The Engineer

LONDON, FRIDAY, SEPTEMBER 12, 1941.

PUBLIC NOTICES

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BEAM ENGINE STEAM PUMPING PLANT

The Witham Third District INTERNAL DRAINAGE BOARD invite TENDERS for the PURCHASE of the BEAM ENGINE STEAM PUMPING PLANT at Dogdyke Pumping Station, Lincs.

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IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

RESTRICTION ON ENGAGEMENT ORDER

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IMPORTANT NOTICE TO ALL ADVERTISERS AND ADVERTISING AGENCIES.

Owing to further drastic limitations in the use of paper it has been decided to reduce the printed area of THE ENGINEER page as from October 3rd. The type space will be :—

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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A Seven-Day Journal

Employment Returns

IT was officially announced by the Ministry of Labour and National Service, on Friday, September 5th, that the number of men and boys registered at Employment Exchanges in Great Britain as wholly unemployed at August 11th was 116,127, a decrease of 3273 amongst men and an increase of 5738 amongst boys as compared with July 14th, the latter being mainly due to the registration of school leavers. Of the total, 32,345 had been classified by interviewing panels as unsuitable for ordinary industrial employment. Those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 15,566; this was a decrease of 5296 as compared with July 14th. Those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 11,982, an increase of 977 as compared with July 14th. The corresponding figures for women and girls at August 11th were 103,644 wholly unemployed (of whom 3623 had been classified by interviewing panels as unsuitable for normal full-time employment, and 4154 had been classified as unable for good cause to transfer to another area although employment was not likely to be available locally), 22,384 temporarily stopped and 586 unemployed casual workers. As compared with July 14th, the numbers wholly unemployed showed a decrease of 6644 amongst women and an increase of 4373 amongst girls, the latter being mainly due to the registration of school leavers, those temporarily stopped a decrease of 2781, and unemployed casual workers a decrease of 85. A table showing the difference between July 14th and August 11th shows the variations in the total numbers of unemployed on the registers in the various administrative divisions. There were increases in the numbers of unemployed in the London and South-Eastern Division, and also in the South-Western, Midlands, North Midlands and Northern Divisions, while decreases were recorded in the Eastern, Southern, North-Eastern, North-Western Divisions and in Scotland and Wales.

National Industrial Mobile Squads

ON Friday, September 5th, it was announced by the Ministry of Supply that with the object of getting production under way in Britain's new arms factories in the shortest possible time, the Ministry of Supply has set up national flying squads of skilled engineers, who are known as the N.I.M.S., or National Industrial Mobile Squads. The increased shortage of skilled labour in many parts of the country is creating its own problem, and the Ministry now finds it necessary to utilise to the utmost the experience and ability of every key man, at centres at which they are most needed, if the output of munitions is to be speeded up to the desired limits. Each of the new mobile squads consists of a number of expert fitters, setters, drillers, turners, or kindred craftsmen from established ordnance factories. These men have volunteered, often at great personal inconvenience, to leave their own districts and apply their specialised knowledge at new centres, and their task is to prepare the way for the introduction of semi-skilled labour and female labour in the effort to extend mass production methods. The practice is to draft a squad of about fifty men, who pool their skill, to individual factories for a period of about thirty days. The squad meets at a central point, complete with its tools and the men's personal belongings, and it is then sent off to a selected centre, which may be in the West Country or in the North-Eastern area, where the services of skilled artisans may be badly needed. The Ministry of Supply states that a tremendous national service is being performed by the National Industrial Mobile Squads, the members of which represent the backbone of Britain's army of war workers. By the willingness of these men to be transferred to work in different parts of the country, it has been possible to achieve during the past few weeks an increased production output.

Industrial Welfare Society

DURING the week-end from Friday, September 5th, to Sunday, September 7th, a conference arranged by the Industrial Welfare Society was held at Reading University. It was the twentieth of these annual conferences and was attended by more than 250 welfare supervisors, employment managers, personnel managers and directors of engineering and industrial firms. In opening the meetings Mr. Robert R. Hyde, the Director of the Society, said that part of the purpose of the conference was to recall to those long engaged in industrial welfare work, and those who had recently taken it up, some of the fundamental principles which underlined that work. He recalled Dr. Elton Mayo's Chicago experiments and his conclusion that the main factor in promoting happiness and efficiency in industry was the relation which existed between executives and operatives. That, Mr. Hyde said, was surely familiar to anyone who had been associated with factory life, and it was the task of the welfare worker to maintain or to build up the right kind of relationship. Too much stress, he said, was perhaps being laid in many quarters on professionalism in the field of welfare work and personnel management, although he did not wish to belittle the great importance of training for the job. With regard to the workers themselves, he did not believe that social stratification was becoming evident between the highly skilled workers, and on the one hand the less skilled workers, and on the other the management group. The very existence of an army of welfare workers, employment managers, doctors, nurses and others in the factories of the country who were not concerned with production, but with the human needs of the workers, surely meant that it was now someone's job to prevent such stratification. In addition, the growth of works councils, committees and suggestion schemes and the taking of meals together in the canteen and not in isolated groups, and the contact between all grades of workers in leisure pursuits, were but an indication that the wiser people in industry to-day were thinking not in terms of management, control and dictation, but were endeavouring to find a way by which all could co-operate in the common task. The paid welfare worker was not of necessity biassed against the worker because he received his wages from the firm, and he, Mr. Hyde, did not believe that the modern worker was prepared to accept exploitation by the employer. Some criticisms of the welfare movement had been based on modern ideas of repetition work and conveyor systems. Such views, Mr. Hyde said, did not represent a true picture of British industry. We were still a country of small factories, and at least half the workpeople were employed in units of less than 250 persons.

Allied Naval and Mercantile Shipping Statistics

ACCORDING to figures which have recently been made available by the Ministry of Information with reference to the strength of the Allied Navies and the merchant fleets which are operating with the Royal Navy and the British Forces at sea, there are in all no less than 187 warships manned by 14,730 officers and men, and 1617 merchant ships, totalling 7,250,000 tons, all of which are co-operating in the cause of freedom. As yet no details are available concerning the ships of the Greek and the Yugoslav navies, nor are particulars disclosed of the number of submarines which are operating with any Allied Navy, beyond the grand total referred to above. The principal warships of the Allied Navies include one cruiser of the Royal Netherlands Navy; nineteen destroyers, comprising three Free French destroyers, six Norwegian destroyers, four Dutch destroyers, and six Polish destroyers. There are nineteen sloops or corvettes, which include eleven Free French, four Norwegian, and four Dutch. The remaining vessels are smaller craft of which no further particulars are given. Other interesting figures are those which relate to the number of Allied merchant ships and their tonnage, which have been sunk by the enemy since each nation became a belligerent. These returns are completed up to June, 1941. Norway heads this list with a loss of 121 ships, and she is followed by the Netherlands with a loss of 77 ships. Greece follows with 65 ships and Belgium and France have each lost 34 ships; while Poland has lost four ships, making a grand total of 335 merchant ships, aggregating in all about 1,502,393 tons.

Science and the World Order

ON Monday, September 8th, it was announced by the British Association (Division for Social and International Relations of Science) that an International Conference on "Science and the World Order" will take place on Friday, Saturday, and Sunday, September 26th, 27th, and 28th, 1941, at the Royal Institute, Albemarle Street, London, W.1. The object of the Conference is to emphasise and to demonstrate the common purpose of men of science in securing a post-war order in which the maximum benefits of science will be secured for all people. Taking part in the proceedings will be representatives of the four Great Powers—Britain and its Commonwealth, the U.S.S.R., U.S.A., and China—together with scientists from the European nations, who will include representatives from Czechoslovakia, Norway, Holland, Belgium, France, and exiled scientists of Germany, Austria, and possibly of Italy. The first session will be held under the chairmanship of Sir Richard Gregory, President of the British Association, who will deal with "Science in Government" and the use of scientific men and scientific methods within departments of government and the development of government research. Professor A. V. Hill will speak on the call which government requirements have made upon the services of scientists and co-operation between America and Great Britain; while Professor J. D. Bernal will deal with scientific organisation within government service and its possible future development. It is hoped that Chinese and Russian representatives will also speak. The second session, which will be under the chairmanship of Mr. Winant, the United States Ambassador, will deal with "Science and Human Needs." Sir John Orr will deal with food problems, Professor Vavilov or another Russian representative with agriculture and food requirements, and Sir Harold Hartley with power and the development of natural resources. An American representative will also speak. The third session will be under the chairmanship of Mr. Maisky, the Russian Ambassador, and will be concerned with "Science and World Planning." An American representative will deal with large-scale projects such as the Tennessee Valley development; while a Russian representative will speak on State planning; and Professor Sargant Florence on the redistribution of population. The fourth session will be under the chairmanship of Dr. Benes, the President of the Czechoslovak Republic, and will deal with "Science and the Technological Advance." The fifth session, under the chairmanship of Dr. Wellington Koo, the Chinese Ambassador, will deal with "Science and Post-war Relief"; while the sixth session, under the chairmanship of Mr. H. G. Wells, will be devoted to "Science and the World Mind."

The Trade Disputes Act

IN the course of a statement which he made at the Trades Union Congress, Sir Walter Citrine recently referred to discussions which are to take place between the General Council of the Trades Union Congress and representatives of the Conservative Party on the question of possible amendments of the Trade Disputes Act. The demand for the amendment of the Act has been renewed since the beginning of the war, and both the late Mr. Neville Chamberlain and the present Prime Minister, Mr. Winston Churchill, have been approached, with the support of the Labour Ministers who have joined the Government. Since an all-party Government in wartime cannot promote domestic legislation which is deeply controversial, Mr. Churchill, with the support of all his Cabinet, adopted the same attitude as Mr. Chamberlain, and requested the General Council not to press for the reconsideration of the Act during the war. The Trades Union Congress, in the belief that it may be possible to obtain some amendments of the Act even during the war without raising serious controversial issues, has now limited its demand to the repeal of two sections of the Act only. The more important of these two sections is that which forbids the affiliation of the Civil Service trade unions with the Trades Union Congress or their association with any political party or organisation, while the other section is that which makes it illegal for any public authority to insist that an employee shall or shall not be a member of a trade union. The object of the forthcoming discussions between the General Council and representatives of the Conservative Party will have as their object the exploring of a basis for some political agreement without which the Government would find it difficult to pass legislation amending the Act.

U-Boat Surrenders to British Aircraft

IN an official announcement made by the Admiralty and the Air Ministry on Tuesday, September 9th, particulars were given of an incident which recently happened in the Atlantic under gale conditions, when a German submarine was attacked and forced to surrender by a Hudson Aircraft of the Coastal Command, the first time, it is stated, that a land plane has forced a submarine to surrender outright. After the aircraft, a Lockheed-Hudson of the Coastal Command, had attacked the U-boat, the crew came tumbling out of the conning tower, waving a white shirt as a token of surrender. The Hudson, without any aid, then held the submarine captive for nearly four hours. A Catalina flying-boat of the Coastal Command then took over the watch duty and it was assisted by other Catalinas and Hudsons for nearly ten hours more. Just as the daylight began to fade, one of our naval vessels arrived to take over guard. By that time the U-boat had been held captive from the air, without any actual combat except the threat of machine guns, for a period of nearly thirteen hours. When the naval ships arrived, the weather was so bad that for several hours it was impossible to lower a boat. For some time the ships had to stand alongside the submarine, covering her with their guns, and waiting for an improvement in the weather. When the gale had somewhat abated and the sea became calmer, it was possible for the submarine to be boarded and her capture completed. That being done, the submarine was taken in tow and has now been brought successfully into harbour. The incident is without doubt one of the most interesting recently recorded, as apart from the capture, from the arrival of the first naval ship, the submarine was covered from the air by Coastal Command aircraft for the whole of the next forty hours.

Historic Accidents and Disasters

No. V

(*Continued from page 83, August 8th*)

H.M.S. "THUNDERER"—PART I

MATHEMATICIANS tell us that the probability of the simultaneous occurrence of two independent events of which the separate probabilities are p_1 and p_2 is $p=p_1 \times p_2$. Let us suppose, for example, that a boiler is fitted with two independent safety valves, and that the probability of either failing to act is one in a thousand. Then the probability that both will stick simultaneously will be not one in two thousand, but one in a million. Let us proceed a little further, and suppose that the probability of the pressure gauge on the boiler failing to register is also one in a thousand. Then the probability that the two safety valves will jam simultaneously with the failure of the pressure gauge is one in a thousand million. Finally, let us add a fourth event. Let us suppose that the probability of the main stop valve on the boiler being left closed when it should have been opened is again one in a thousand. Then the probability of all four events occurring simultaneously is one in a million million.

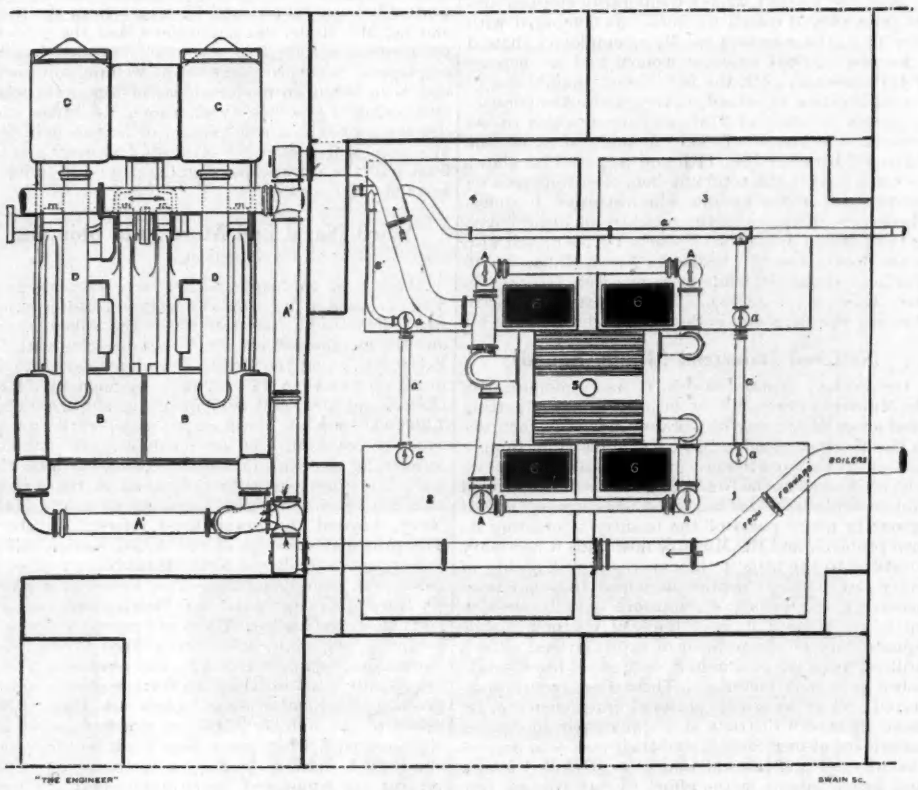
In practice things do not always work out in the way mathematicians say they should. Nevertheless, we must pay *some* respect to mathematics. If we are told that an accident occurred as a result of the concatenation of a number of independent events, and if the mathematical probability of the simultaneous occurrence of these events reaches some extraordinarily remote chance such as one in a million million, then it is very desirable that we should be cautious in accepting all that we are asked to believe.

The example cited in the above remarks is not a fanciful one. The events mentioned formed the sequence of incidents which, according to the evidence subsequently obtained, led to the disastrous explosion of a boiler in H.M.S. "Thunderer" on July 14th, 1876. She was a doubly unfortunate ship. Almost incredibly an analogous concatenation of apparently independent events resulted in an equally disastrous explosion of one of her guns some years later. The lesson which we find starkly illustrated by her history is that in the handling and control of natural forces, the occurrence of that which by all the rules should be highly improbable should not be ruled out of consideration, and that the duplication and triplication of precautions against mishap provides no certainty that disaster will be avoided.

The "Thunderer" was one of Mr. E. J. (Sir Edward) Reed's low-freeboard, mastless, seagoing turret ships, concerning which we had something to say in our earlier article on the capsizing of the "Captain." She was a battleship of 9190 tons displacement, with a length of 285ft., a beam amidships of 62ft., and a freeboard when ready for sea of 4ft. 6in. Her main armament consisted of two turrets, each containing two 12in. muzzle-loading guns. She was propelled by twin screws driven by engines of 5600 H.P., which were supplied with steam at 30 lb. gauge pressure by eight rectangular wet-bottom boilers of the pattern commonly adopted in the Navy at that date. She was built at Pembroke Dockyard, and was launched in March, 1872. Her engines and boilers were made by Humphrys and Tennant, of Deptford.

The ship was brought round to Portsmouth under her own steam in the early months of 1873, but for various reasons—primarily because following the disaster to the "Captain" all low-freeboard ships fell under suspicion—her completion was delayed, and the acceptance trials of her engines and boilers were postponed. She lay at Portsmouth for over three years. During that period the Admiralty assumed responsibility for keeping her engines and boilers in order. On July 10th, 1876, under the general charge of Captain Waddilove, R.N., in command of the Steam Reserve, and manned partly by naval ratings and partly by contractor's men under Mr. Humphrys, she was taken out to Spithead for a preliminary trial of her engines. On the 12th, similarly manned, she proceeded to the measured mile, but while she was making her second run over it a copper feed pipe gave way and the trial was stopped. On Friday, July 14th, she was being prepared for a resumption of the measured mile trials. At 10.15 a.m. the fires in her main boilers were lit. At 10.50 a.m. there was 15 lb. of pressure in the main steam pipe, and the fires of the auxiliary boiler were lit. At 11 a.m. the main boilers were under a pressure of 20 lb., and at 11.15 a.m. steam was up in the auxiliary boiler. At 1.13 p.m., while the ship's speed was being worked up for the first run over the measured mile, one of the boilers in the after stokehold exploded with great violence. Fifteen men were killed outright, and sixty-three, of whom thirty subsequently died of their wounds, were injured.

A plan of the after stokehold and a contemporary engraving of the exploded boiler are reproduced herewith. The four boilers, 1, 2, 3 and 4, were arranged about a central firing aisle. The uptakes, 6, led the products of combustion to the funnel past a superheater 5. Each boiler had a main stop valve A. The main steam pipes A^1 conducted the steam to the engines, of which a pair of the cylinders B with their condensers C and eduction pipes D are indicated on the engraving. A separate boiler was provided in the forward stokehold for supplying the auxiliaries with steam, but provision was made for an alternative supply of steam to the auxiliary machinery from the main boilers by way of the auxiliary stop valves a and steam pipes a^1. The boiler which exploded was that marked No. 1. The explosion forced the plates off the front of that boiler in the direction of boiler No. 3, tearing them through the rivet seams and did much other damage, all of which unmistakably indicated that the boiler had been subjected to excessive pressure. There was no sign of water shortage.


C
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exploded boiler was found on the stokehold floor with its attaching flanges broken. Both the valves were perfectly free to turn on their seatings and to rise off them in all positions. There was no sign whatsoever of the valves having been interfered with to make them operative at a pressure in excess of the designed pressure.

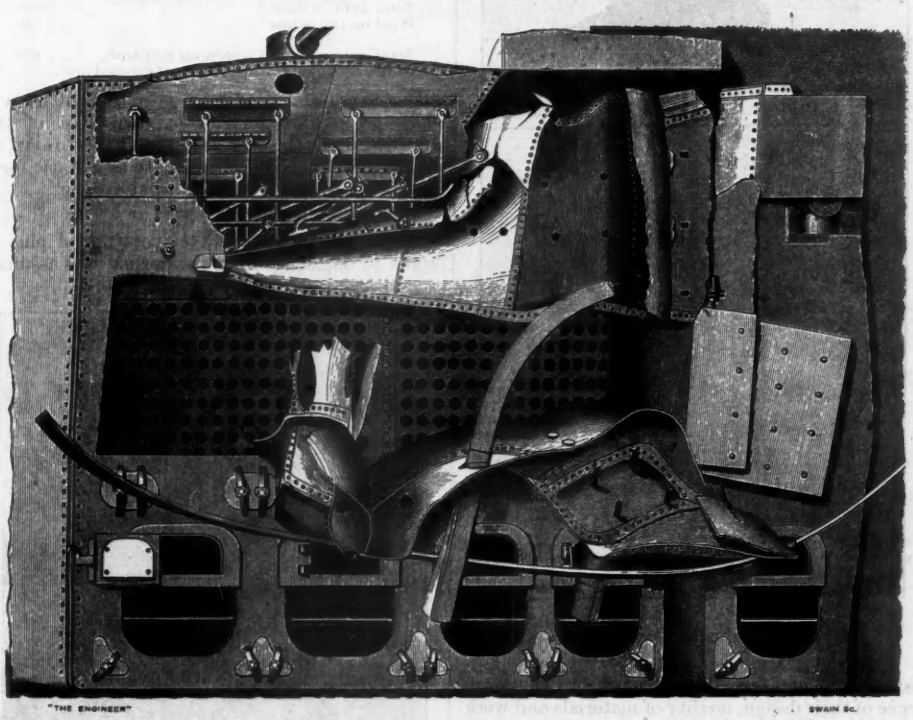
It should be made clear that although the Admiralty had for upwards of three years been responsible for maintaining the engines and boilers of the "Thunderer" in good condition, although a naval officer was in general command of her on the day of the disaster and although a party of naval stokers assisted in the firing of the boilers, the machinery had not yet been officially taken over. The contractors were still responsible for its satisfactory performance and, led by Mr. Humphrys, had complete control over its operation during the trials and the preparations for them. The long delay which had occurred between the installation of the machinery and the acceptance trials and the fact that during that period the care of the machinery had been in the hands of others must have increased the contractors' natural anxiety to ensure that the engines and boilers would give a good account of themselves on the appointed day.

We know that in those days certain reprehensible expedients were resorted to during ships' trials in order to get impressive results from the machinery. In the case of the "Thunderer" some suspicion may force its way into our minds that something of the kind might have been responsible for the disaster. A picture can be built up involving the deliberate overloading of the safety valves and the wilful damaging of the pressure gauge in order to disguise the interference with them. The scheme, it may be supposed on this basis, ended in disaster because someone made a mistake in the manipulation of the stop valves of the boiler which had been tampered with, closing the main valve when it should have been left open. The fact that the safety valves showed no signs of having been tampered with does not run counter to this argument. The damage done to the valve box by the explosion was quite sufficient to have removed all traces of interference. One fact, however, seems to exonerate the contractors or their workpeople from all suspicion of this kind of malpractice. To have tampered with the safety valve of one boiler out of a total of eight feeding the engines through a common connection would have been futile. Any extra pressure generated in the boiler which had been tampered with would have been blown to waste through the safety valves of the other boilers.

Improbable as it may seem, the disaster, we appear bound to conclude, was caused by the concatenation of three separate events, the failure of the pressure gauge to register, the fact that the main stop valve was closed when it should have been open and the simultaneous sticking of the two safety valves.

Why did the pressure gauge fail to register? It was of the Bourdon pattern and was graduated from zero up to 35 lb. The hand could, however, go beyond the 35 lb. mark. Under a pressure of 44 lb. it would be carried farther on and come to rest against the wrong side of the zero stop pin. The gauge was at too great a height above the stokehold floor to enable anyone to say whether it was reading zero or whether the hand had gone right round the dial. If, with the hand against the wrong side of the stop pin, the glass were broken—as it was on Harding's orders—and the hand lightly touched, it could lift over the pin. Assuming the boiler pressure was in excess of 44 lb., it would then start a second journey round the dial and would continue to move until it reached the point at which the toothed sector came out of gear with the pinion operating the hand. Mr. Bramwell tested all the remaining seven gauges of the "Thunderer" to determine at what pressure on the second round the sector would come out of gear. The figure varied from about 53 lb. to 65½ lb., the average being about 58½ lb. Taking this average figure as correct for the gauge of the exploded boiler, we conclude that with a pressure of 58½ lb. or upwards in the boiler the hand of the gauge when released from the stop pin would move forward and come to rest, on the disengagement of the sector, at an apparent pressure of 58½ lb. minus 44, or 14½ lb. It will be recalled that when the glass was broken the hand jumped round from apparently zero to 15 lb. and there stopped.

This theory, fitting the facts so exactly, appears to have been generally accepted as a satisfactory explanation of the seeming failure of the pressure gauge to register. Yet if it is true it raises an important point which escaped notice at the time.



CONDITION OF THE EXPLODED BOILER

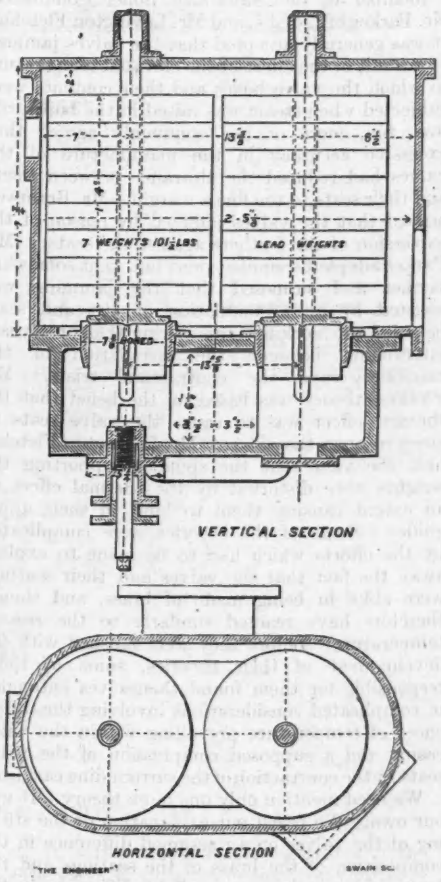
As has already been stated, the fires in the boilers were lit at 10.15 a.m. At about 11.15 a.m. leading stoker Wells noticed that the gauge of No. 1 boiler was indicating zero pressure, while those of the other boilers were reading 26 lb. Shortly afterwards, when the glass was broken, the hand of the pressure gauge on No. 1 boiler jumped round to 15 lb., implying on Mr. Bramwell's theory that the pressure on that boiler was, at the least, 59 lb. Forced draught was not being used and the stokers were picked naval men under close supervision. Yet somehow or other, we are to suppose, the rate at which No. 1 boiler was fired was so much greater than that at which boilers 2, 3 and 4 were fired that the pressure in that boiler was raised during the first hour or so to a value more than twice the pressure generated in the other boilers during the same period.

One other point should be noted. Mr. Bramwell's theory seems to imply that the main stop valve of No. 1 boiler was closed from the start and that the steam required at 11 a.m. for the capstan engine, before the auxiliary boiler was ready to supply it, was not taken from that boiler. If we suppose otherwise as regards either of these features, then, still holding to Mr. Bramwell's theory, the relative rate of firing of No. 1 boiler must have been even more excessive than we have pictured it to have been.

If we adhere to Mr. Bramwell's theory and accept its apparent implications—namely, that the stop valve of No. 1 boiler was closed from the start, and that the steam for the capstan engine was not obtained by opening the auxiliary stop valve of that boiler—then we are deprived of a fairly simple and reasonable explanation of why the main stop valve was found closed. The call for auxiliary steam from the main boilers at 11 a.m. provided an occasion for manipulating the stop valves on those boilers or on one of them. The divided responsibility in the engine-room and stokeholds provided an opportunity for the valves to be mismanipulated. It is conceivable, for example, that the steam for the capstan engine was obtained by opening the auxiliary valve of No. 1 boiler in the *forward* stokehold, and that when the order was given later to someone to close that valve, he made a mistake, went to the *after* stokehold and closed the valve on No. 1 boiler, which he found open—the main stop valve.

We cannot, however, reconcile this explanation with Mr. Bramwell's theory, because it implies that the main stop valve of No. 1 boiler in the after stokehold was open until it was closed in error at or some time after 11.15 a.m. If it were open at that time, the very time when the pressure gauge was noticed to be reading zero, the pressure in No. 1 boiler must have been 26 lb., as it was in the other boilers, and not upwards of 59 lb., as required by Mr. Bramwell's theory.

We must regretfully leave at this point the question of why the pressure gauge apparently failed to register and the obviously related question of how and when the main stop valve was closed. At the time these problems were almost completely swamped by the attention paid to the third problem—Why did the safety valves stick? After the explosion the safety valve box and its contents were found in a damaged condition, but the damage was not such as to prevent the clear establishment of the fact that the valves as found were free to rotate on their seatings and to rise through the correct amount at all angular settings. Yet the valves just before the explosion must, if we exclude deliberate interference with them, have been jammed down on their seats with a force three or four times at least as great as that under which they were designed to lift. Further, the two valves were independent, except for the fact that both were housed within the same casing. Yet both apparently stuck simultaneously. Here there seemed to be a first-class mystery, the solution of which was clearly of immediate moment to all engineers. In his address that year to the British Association, Sir William Thomson expressed the disquiet which the accident engendered. "Is there," he asked, "in the British Navy or in a British steamer or in a British land boiler, another



TWIN SAFETY VALVES

safety valve so constructed that by any possibility, at any temperature, or under any stress, it can jam? If there is, it must be instantly corrected or removed."

Innumerable theories were propounded to account for the sticking of the valves of No. 1 boiler, but none of them received general acceptance. In nearly every instance the argument was based on the apparent fact that while the valves were free on their seats at atmospheric temperature and pressure, they became bound firmly down under a pressure of 30 lb.—or less—and at the corresponding temperature—274 deg. Fah. Another apparent fact which weighed with the propounders of some of the theories was that while the valves of No. 1 boiler had jammed, those of the other boilers, although of exactly the same design, had remained free. Each of these "apparent facts," however, involves an assumption. The valves of No. 1 boiler were found to be free on their seats *after* the explosion. There was no positive evidence that they were free when the fires were lit on the morning of the disaster. They may have been jammed from the start and been freed as a result of the explosion. Again, since all the remaining seven boilers were in communication with one another, the safety valves of one or more of them might have been jammed like those on No. 1 boiler without anyone being aware of it.

The theories which commanded widest attention were those advanced by Mr. Bramwell, Mr. Phillips, a member of the Admiralty Boiler Committee, Mr. Parker of Lloyd's, and Mr. Lavington Fletcher. It was generally accepted that the valves jammed as a result of the effect of the elevated temperature to which the valve boxes and their contents were subjected when steam was raised in the boiler. It was, too, more or less commonly agreed that excessive accuracy in the manufacture of the valves had reduced the clearance between them, and their seats to too fine a margin. Mr. Bramwell argued that the valves jammed by reason of the expansion of the feathers against the seats. Mr. Parker adopted a similar view, but went somewhat farther and supposed that the jamming was assisted by an accumulation of dirt and scale between the working faces during the three years intervening between the installation of the machinery and the contractors' trials. Mr. Phillips' theory was based on the belief that the thermal effect was to cause the valve seats to creep in upon the valves. Mr. Lavington Fletcher held the view that the spindles supporting the weights were distorted by the thermal effect to an extent causing them to bind in their upper guides. Some of the theories were complicated by the efforts which had to be made to explain away the fact that the valves and their seatings were alike in being made of brass, and should therefore have reacted similarly to the rise in temperature. Before they were finished with the development of their theories, some of those responsible for them found themselves entangled in complicated considerations involving the differences of temperature prevailing within the valve casing and a supposed compression of the valve seats by the contraction of the surrounding cast iron.

We need mention only one more theory. It was our own. We based our explanation of the sticking of the valves on an assumed difference in the composition of the brass of the seatings and the brass of the valves, on a slight difference in the diameters of the two valves, on an assumed interchange of the valves during some preceding inspection, on the larger valve in the smaller seating jamming as a result of the thermal expansion when steam was raised, and of the smaller valve in the larger seating sticking by corrosion during its period of disuse. This explanation no doubt harmonises with all the known facts connected with the sticking of the safety valves. But it piles supposition upon supposition until we are left staggering under the aggregate load of improbabilities invoked in explanation of the separate features of the disaster.

Rather than accept that burden we would prefer to believe that the pressure in the boiler when the hand of the gauge was released was really only 15 lb., that the safety valves were not jammed on their seats, and that the boiler exploded as a result of the delayed ebullition of steam from the water contained in it. This theory, a measure of the despair felt by some engineers in their endeavour to account for the explosion, found some expression at the time. Equally despairing to-day, we would welcome it with open arms if we felt sure that we understood fully what is, or was, meant by "delayed ebullition."

(To be continued)

Failure of Tacoma Bridge

No. III

(Continued from page 146, September 5th)

THE following section of the report is a review in some detail of the design of the Tacoma bridge. We excerpt from it certain comments that are of special interest.

Review of the Design of the Tacoma Narrows Bridge

The behaviour of the Tacoma Narrows bridge during the hour before the final failure of its centre span floor was a severe test of the strength of the structure as a whole, as well as of its major component parts. Under the violent dynamic motions and during the final failure certain parts of the floor structure, the suspenders, the cables and the towers were subjected to stresses far beyond the safe stresses for which these parts were designed, and at many points to stresses under which failure had to result. That under these severe stresses the main carrying members, in particular the towers, did not actually fail attests to the excellence of their design, quality of materials and workmanship, and to the ample margin of safety which the structure would have had except for the severe dynamic motions. A review of the design of the structure on the basis of accepted requirements for strength and other structural qualities confirms that conclusion.

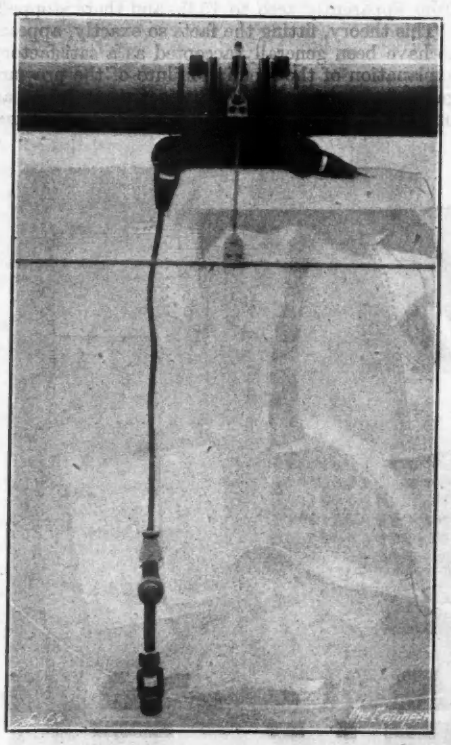


FIG. 18—SOUTH CABLE AFTER FAILURE

* * * *

The suspension type of bridge was unquestionably the most suitable and most economical type for the purpose and the locality. The arrangement of spans and the location of the anchorages were evidently chosen after careful study of the geological and topographical conditions for the pier and anchorage foundations and the economics of the structure, and could not be materially improved.

* * * *

The capacity of the bridge, a two-lane roadway and two footwalks, appeared from the prospects of traffic development to be ample for many years to come, and as much as could be justified economically. To take full advantage of the economy of the narrow roadway, however, the designers adopted an extraordinarily small width of structure compared to its span. Their expectation that the bridge would have adequate lateral rigidity under wind pressure was unquestionably justified.

Based on a detailed estimate made by the engineers of the Washington Toll Authority, the average weight of the suspended structure as built is 5700 lb. per foot in the centre span and 5740 lb. per foot in the side spans. This compares with a dead load of 6000 lb. per foot of bridge assumed for the design. This quite appreciable decrease of 300 lb., or 5 per cent., in the actual weight resulted principally from a modification of the design of the roadway slab and floor steel.

The weight of 5700 lb. is made up as follows :—

	lb.
Floor slabs, lighting, &c.	2650
Floor steel and laterals	720
Stiffening girders	900
Cables with accessories	1430
Total dead load of centre span	5700

For the design of the floor system and suspenders the H-20 loading (20-ton trucks) of the specifications of the American Association of Highway Officials was assumed. This loading is now generally adopted for the design of bridges on first-class highways.

For the stiffening girders, cables and towers a live load of 1000 lb. per foot of bridge was assumed for the design.

* * * *

The following static wind forces were assumed for the design :—

On Suspended Structure, Per Lineal Foot of Bridge

	lb.
Wind on moving load	200
Wind on floor structure (1½ by 8ft. by 30 lb.)	360
Total wind on floor	560
Wind on two cables	60
Total wind on loaded suspended structure	620

On Towers.—50 lb. per square foot of exposed area.

This horizontal wind force is equivalent to over 50 lb. per square foot of exposed area of the unloaded floor, the two cables, and the towers, as seen in elevation, and is adequate as a static force for the proportioning of the wind system.

* * * *

A maximum change in temperature of plus or minus 40 deg. Fah. from the normal was assumed for the design. This is entirely sufficient for the locality of the Tacoma Narrows bridge.

FIG. 19—CENTRE OF NORTH CABLE AFTER FAILURE

* * * *

The curves of vertical deflections under maximum assumed live load at normal temperature are shown in Fig. 21. The maximum deflections from live load and temperature are 13·5ft. near the quarter points and 13·4ft. at the centre of the centre span. The greatest deflection in the side spans is 10ft.

The floor slab and stringers are located near the neutral axis of the stiffening girders, and therefore are practically free from bending stresses from the vertical deflections imposed by the cables.

* * * *

The general arrangement of the stiffening system and the make-up of the stiffening girders are not unusual. Plate girders have been used in a number of suspension bridges. They are being adopted to a growing extent and with increasing proportions in bridges of all types because of economy and

structural simplicity. When the required depth exceeds the practicable or economical depth of plate girders open trusses are the proper solution.

The 8ft. girders are so shallow and flexible that they exerted almost no stiffening effect upon the cables, except locally. Evidently the designers had relied on the weight of the long span of the birdge and on the relatively small cable sag to provide the necessary vertical rigidity. There is every evidence that in so far as rigidity under moving loads is concerned their judgment was justified. They had not expected that aerodynamic dynamic longitudinal motions from wind action, while permitting the slow but much larger motions from temperature changes. Hydraulic jacks acting between the ends of the floor and the towers (Fig. 20) were adopted for the Tacoma Narrows bridge to act as bumpers or shock absorbers. Acting in this way they prevented longitudinal motion only partially because the structural details transmitting the force from the floor to the hydraulic jacks permitted considerable play, with the result that the installation proved largely ineffective in checking vertical oscillations.

stays, because of their short length and therefore limited elastic stretch, can therefore be designed only for very moderate deformations of the cables. Within such deformations they exert a noticeable, but limited, damping effect. This was clearly observed on the Bronx-Whitestone bridge. On the Tacoma Narrows bridge it was apparently less marked. When the motions become as large as they did in the Tacoma Narrows bridge, and the stays do not have a high initial tension, the cables impose alternately slackening of one and excessive strains with impact on the other of the two stays.

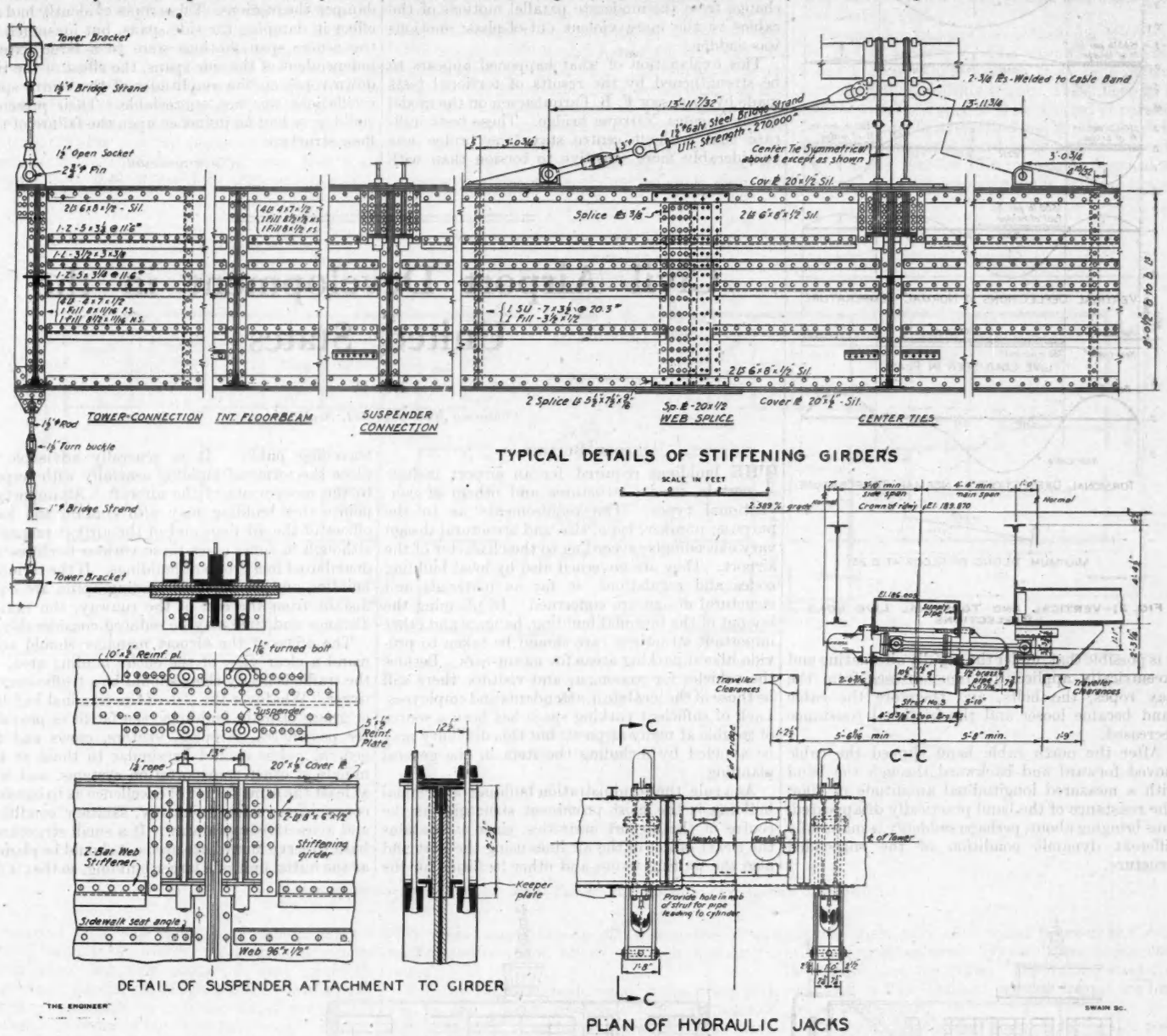


FIG. 20—DETAILS OF STIFFENING GIRDER, SUSPENDER ATTACHMENT, AND HYDRAULIC DAMPING JACKS

action could become so powerful as to put the great suspended mass of the structure into dangerous or objectionable motion.

* * * *

The width of the wind truss between centres of stiffening girders is 39ft., or only 1/72 of the span length. It is thus the most slender and flexible wind truss of any of the large suspension bridges, the nearest being the Golden Gate bridge with a width to span ratio of 1/47. The lateral deflection of the truss at mid-span under full wind force on the centre span is 20ft., or 1/140 of the span length. This deflection is controlled largely by the cables to which the major part of the floor wind load is transmitted. The wind truss of the Tacoma Narrows bridge is discontinuous at the towers.

* * * *

The analysis which is contained herein, corroborated by the behaviour of the structure, indicates that the effect of a flat cable on the vertical rigidity of the suspended system was overestimated, and was by far not sufficient to offset the flexibility permitted by other elements of the structure.

* * * *

Damping Installations

Hydraulic Jacks.—The devices at the towers were designed primarily to steady the floor against

Experience at the Bronx-Whitestone bridge proved that such damping devices at the towers were not fully effective until they had been made sufficiently strong and rigid to prevent play and elastic yield. This was possible only by fixing the ends of the floor to the towers by direct friction, which permits motion only when, under the relatively much larger temperature forces, the frictional resistance is overcome. The effectiveness of this device in damping vertical oscillations was observed, not only on the bridge proper, but was subsequently demonstrated on the model of the Whitestone bridge.

It is doubtful that even similarly effective friction devices in the Tacoma Narrows bridge would have damped the structure sufficiently to prevent, or materially reduce, the much larger oscillations.

Stay Ropes at Centre of Span.—These stays were intended primarily to assist in checking longitudinal motions of the floor by tying the latter to the cables. Incidentally, in combination with fixed ends of the floor they tend to dampen the vertical oscillations of the cables by restraining the longitudinal movement of the centre of the cables. They could not, and were not intended to, prevent longitudinal motions of the cables entirely, because this would involve very large stresses in the stays and would materially alter the deformations and the stress condition in the cables. These centre

The result is that under large distortions of the cables the stays, or their connections, may break or as happened in the Tacoma Narrows bridge, the cable band to which they were attached may slip when the stay rope stress becomes sufficient to overcome the frictional resistance of the cable band.

Similar experience on the Bronx-Whitestone bridge in respect of alternate slackening of the central stay ropes, as at first installed, led to their replacement by heavier ropes, without turnbuckles, with more rigid connections, and with a large initial tension which prevented slackening.

From these experiences the conclusion may be drawn that central stay ropes, when properly designed, exercise a limited damping effect on vertical oscillations, but they are largely ineffective when loose and may be a source of danger when the motions of the cables become large. Observations on the model of the Bronx-Whitestone bridge showed that the damping effect of the central stays becomes overshadowed by the effect of the stay ropes from the tops of the towers to points on the floor.

The Slipping of the Cable Band and its Effect on the Motions.—It can be estimated that under certain possible force conditions, particularly torsional forces which tend to create out-of-step oscillations of the two cables, stresses approaching the strength of the centre stay ropes or the fric-

tional resistance of the cable band can be produced.

The stay ropes had a strength of at least 270,000 lb. The cable band was tightened by six bolts with a stress which may reasonably be estimated at 225,000 lb. The cable band friction was then probably at most 60 per cent., or 135,000 lb.

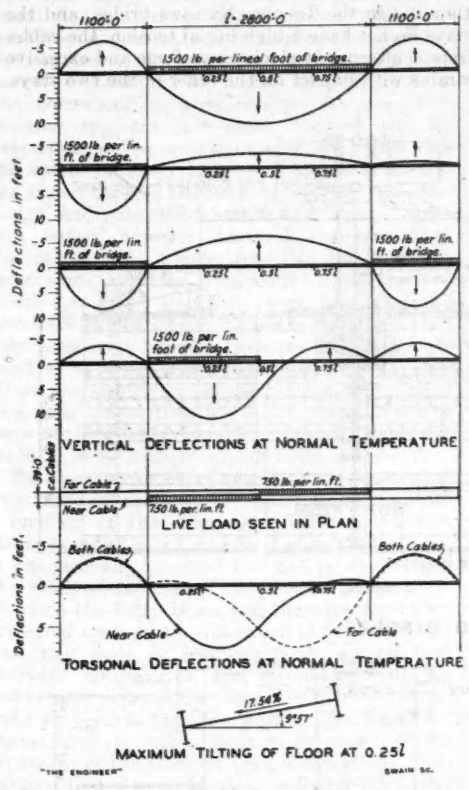


FIG. 21—VERTICAL AND TORSIONAL LIVE LOAD DEFLECTIONS

It is possible that, under the rapidly alternating and excentrically applied dynamic stresses from the stay ropes, the bolts, and therefore the cable band became looser and the frictional resistance decreased.

After the north cable band slipped the cable moved forward and backward through the band with a measured longitudinal amplitude of 40in. The resistance of the band practically disappeared, thus bringing about, perhaps suddenly, a materially different dynamic condition of the suspended structure.

There can be little doubt that, as long as both cable bands were tight, and the stay ropes tied the cables to the floor, they were effective in preventing out-of-step motions of the cables with a node at the centre. When one cable band became ineffective it rendered the structure more sensitive to torsional motions. Its sudden slipping induced a large torsional moment in the horizontal plane, which in turn caused the cables to oscillate out of phase. This action was possibly aggravated by dynamic effects created by the sudden slipping of the cable band. Observations indicated that the change from the moderate parallel motions of the cables to the more violent out-of-phase motions was sudden.

This explanation of what happened appears to be strengthened by the results of torsional tests made by Professor F. B. Farquharson on the model of the Tacoma Narrows bridge. These tests indicate that without centre stays the bridge was considerably more sensitive to torsion than with stays attached to both cables. Therefore the stays must have exerted considerable restraint on the cables to get out of phase and this accounts for the fact that no torsional motions were observed as long as the stays held both cables. The model tests show also that with stays removed at one cable the bridge became more sensitive to torsion, although not as much as without stays.

Tie-down Ropes in the Side Spans.—Some time prior to the failure wire ropes attached to the floor in the side spans and firmly anchored were installed with an initial stress of 100,000 lb. in an effort to dampen the motions. These ropes evidently had an effect in damping the side spans, but inasmuch as the centre span motions were to a large extent independent of the side spans, the effect of the tie-down ropes on the amplitudes of the centre span oscillations was not appreciable. Their presence could have had no influence upon the failure of the floor structure.

(To be continued)

Civil Airport Development in the United States

No. IV

(Continued from page 151, September 5th)

Airport Buildings

THE buildings required for an airport include certain special structures and others of conventional types. The requirements as to the purpose, number, type, size and structural design vary exceedingly, according to the character of the airport. They are governed also by local building codes and regulations, so far as materials and structural design are concerned. In planning the lay-out of the terminal building, hangars and other important structures care should be taken to provide liberal parking areas for motor-cars. Besides the vehicles for passengers and visitors, there will be those of the local staff, attendants and employees. Lack of sufficient parking space has been a source of trouble at many airports, but this difficulty may be avoided by including the item in the general planning.

As a rule, the administration building or terminal building is the most prominent structure, as the centre of the airport activities, since it contains the ticket offices of the air lines using the port and also the waiting rooms and other facilities for the travelling public. It is generally advisable to place the terminal building centrally with respect to the movements of the aircraft. At important points this building may also contain the local offices of the air lines and of the airport manager, although in some cases these various facilities are distributed in a group of buildings. If the terminal building and its adjacent loading apron are equidistant from the end of the runway, the taxi-in distance and time may be reduced considerably.

The office of the airport manager should command a clear view of the entire landing area. If the traffic is heavy there should be a traffic control tower. Whatever the size of the terminal building or group of main buildings, the facilities provided for passengers, shippers, visitors, crews and the general public should be similar to those at terminals of other transportation systems, and with at least the same degree of excellence as to comfort, convenience, safety, courtesy, sanitary conditions and attractive appearance. If a small structure is built to serve immediate needs, it should be planned as the initial unit of a larger building, so that it can

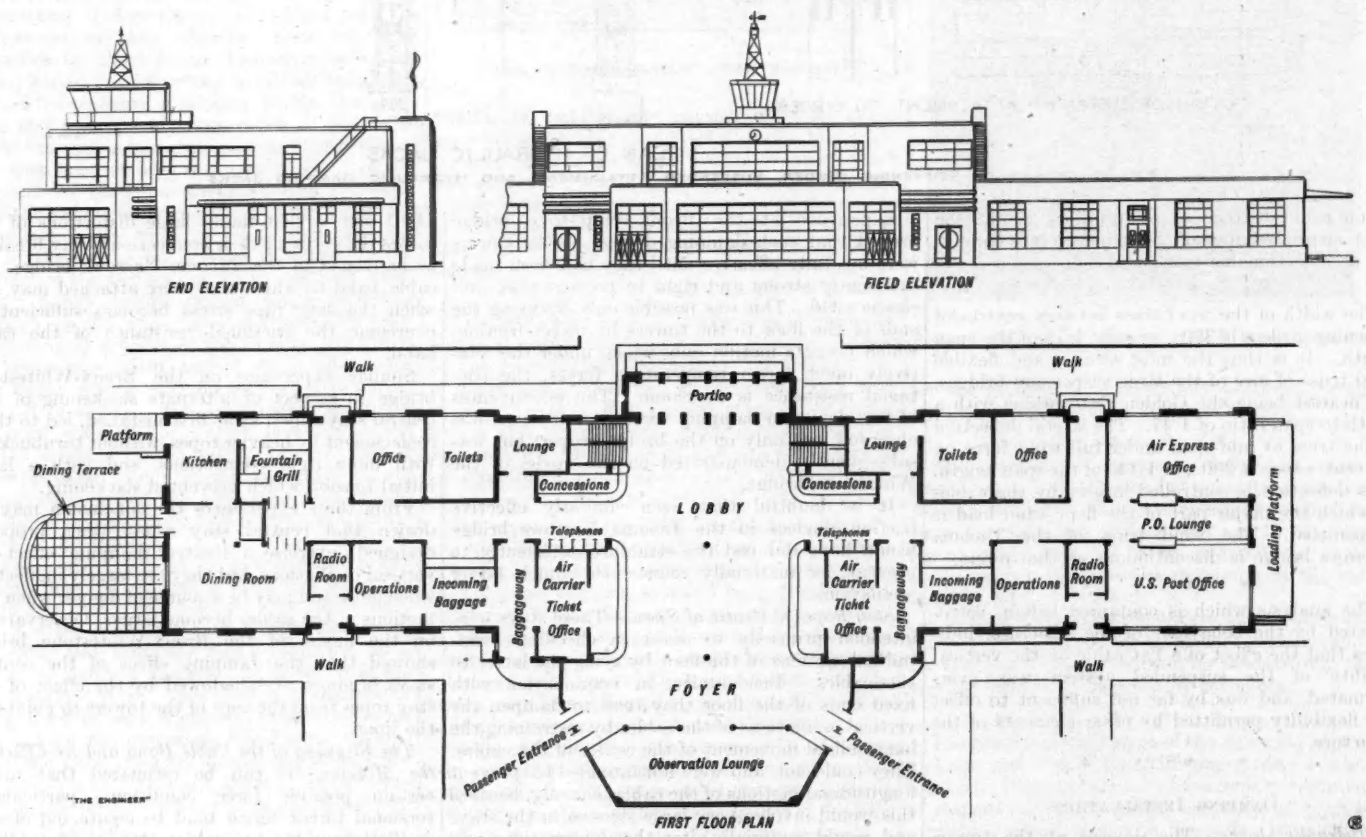


FIG. 5—SUGGESTED DESIGN FOR TERMINAL BUILDING AT MEDIUM-SIZED AIRPORT

be enlarged on a definite plan as traffic may require. In this way the expansion will cause a minimum of inconvenience, and expensive remodelling will be avoided.

Among the various facilities to be provided at the terminal building there may be included a Government weather bureau office, airways communications offices, ticket offices, mail and baggage rooms, parcels check rooms; telegraph, telephone and information offices; waiting, rest, wash and toilet rooms; restaurant, lunch rooms and counter for "soft" drinks and light meals, and possibly a post office. In addition, there will be concession stands for the sale of newspapers, magazines, sweets, stationery, souvenirs and perhaps clothing or haberdashery. It is desirable for the waiting room to command a view of the airport—preferably facing the landing area. It should also have a smooth and unbroken floor level from the main entrance to the exit for access to the field or the aeroplanes. All offices opening upon this room should have their floors flush with it. Incoming passengers from the aeroplanes should not be routed through the waiting room, causing general disturbance, but this matter is very generally neglected. Acoustical design and the use of sound-proofing materials in interior finish are highly desirable in order to minimise the inevitable noise.

Each transport line usually requires its own ticket office, although a joint office is sometimes arranged. Ample space should be provided for handling ticket sales and baggage checking at the same counter, and care should be taken to have the ticket windows or counters, baggage counters and general counter space all at the same convenient height. Mail and express—or parcels—should be handled to and from the motor trucks at an outside covered platform. In view of the greatly varying requirements of the mail and express services, the representatives of the post office department and the parcels delivery agencies should be consulted in preparing the preliminary design. Allotments of space will vary, but in general the weather bureau office may require from 800 to 1400 square feet of floor space, and airway companies from 400 to 800 square feet. When the volume of air traffic necessitates a traffic control system the minimum floor space for this office will be about 1000 square feet. The control tower for regulating air traffic would have a floor area of 150 to 250 square feet, and should be so placed—preferably above the roof of the terminal building—as to provide a full and clear view of the landing strips, runways and taxiways.

Typical lay-outs or plans suggested by the American Civil Aeronautics Administration for terminal buildings at medium-sized and large airports are shown in Figs. 5 and 6, respectively. In both cases the building is surmounted by a traffic control tower. In these drawings, which are merely suggestive of actual design, no attempt is made to define the architectural treatment, except that they indicate a very considerable proportion of glazed or window area for offices and public spaces. This may include the use of non-transparent glass bricks or blocks for certain parts of the exterior walls, as in many recent buildings of the commercial class.

The smaller terminal building, Fig. 5, is approximately T-shaped in plan, 150ft. wide and 60ft. deep. Its central part is devoted mainly to the waiting room, around which are grouped the ticket, baggage and telegraph offices. In one arm of the T are the dining room and kitchen, while the other arm contains offices and rooms for the mail and express services. Rest rooms and toilet rooms are arranged on either side of the broad entrance hall or lobby. A continuation of the waiting room extends into a glass-walled enclosure in which are the gates for admitting passengers to the field. On the upper or second floor are the weather and communications offices, the pilots' chart room and club room, miscellaneous offices and the airway traffic control room, above which is the control tower.

For the terminal building of a major airport, Fig. 6, the plan is relatively long and narrow, 300ft. by 62ft. A sheltered entrance on the driveway side opens into a central waiting room, from each side of which extends a corridor flanked by baggage rooms, toilet rooms, offices, &c. One corridor leads into a dining room, and the other into a post office and parcels express office. The waiting room is flanked by ticket offices and has in the centre an "island" with information counter and telegraph offices. A projecting bow at the end of the waiting room has gates along each side for access to the field, while the forward end forms an observation room.

In this plan the gates open into a broad space or concourse from which radiate nine paths, 8ft. wide; six of these are for passengers, while the middle and two end paths are for the baggage trucks. A smaller upper floor has accommodation for the pilots and space for offices, and weather bureau; on the field side is the traffic control room, with the control tower above it. The weather bureau includes a theodolite tower, with revolving turret, as in an astronomical observatory. Workshops, store rooms, heating plant and other facilities are arranged in a basement floor. The nine paths lead into a broad curved concourse along the edge of the apron and having its outer side separated from the field by a fence provided with gates for regulating movements to and from the field. Mooring pivots for the aeroplanes, 100ft. apart, are arranged 40ft. beyond the fence.

Hangars for housing and servicing the aeroplanes are of numerous designs, and are built of timber, concrete and structural steel. In view of the increase in size and weight of aeroplanes, the minimum width of doorways should be 100ft., except in the case of privately owned aircraft. Heights of doorways range from 22ft. for 100ft. width, 22ft. to 28ft. for 120ft. width, 28ft. for 160ft., and 36ft. or more for a width of 180ft. A typical plan for a hangar 200ft. long with 180ft. clear width of aeroplane space shows a total width of 260ft., including two side spaces 40ft. wide. On one side this space is utilised for office purposes, while on the other side are the repair shop, shop foreman's office, locker and toilet rooms and heating plant.

Designs for hangars, accompanying the report, are merely tentative. One example is a timber frame hangar, 100ft. wide in the clear; it has a roof of 100ft. bowstring trusses, 11½ft. deep at the centre, with the upper or arched chord of parabolic form built up of sixteen timbers, 2in. by 4in., while the lower horizontal chord or boom is composed of two timbers, 4in. by 10in. on edge. Vertical and diagonal members are single 4in. by 4in. timbers, having their ends sandwiched between the chord timbers and secured by steel ring connectors supplementing the bolts. No vertical steel rods are used in these trusses. Similar trusses are built up to 200ft. span.

Exterior inclined wind braces hold the side posts and frames in the vertical position. Doors made up of sliding panels fold or telescope together into exterior pockets, or into pockets formed in the repair shop along the side of the building, so as to give a clear end opening 180ft. wide and 22ft. high. The rear end is enclosed and has only a service door. Grooved rollers in the bottom of the panels of the main doors travel on a steel T-rail embedded in a concrete sill, the top of the concrete being formed as a shallow drain or gutter to expose the head of the rail.

Still another design is for a hangar 100ft. by 100ft., with a 30ft. shop addition along one side. The main space is covered by plate girder rigid frames of 100ft. span, 21ft. high at the walls and 36ft. at the centre. Exterior steel A frames or buttresses form wind braces.

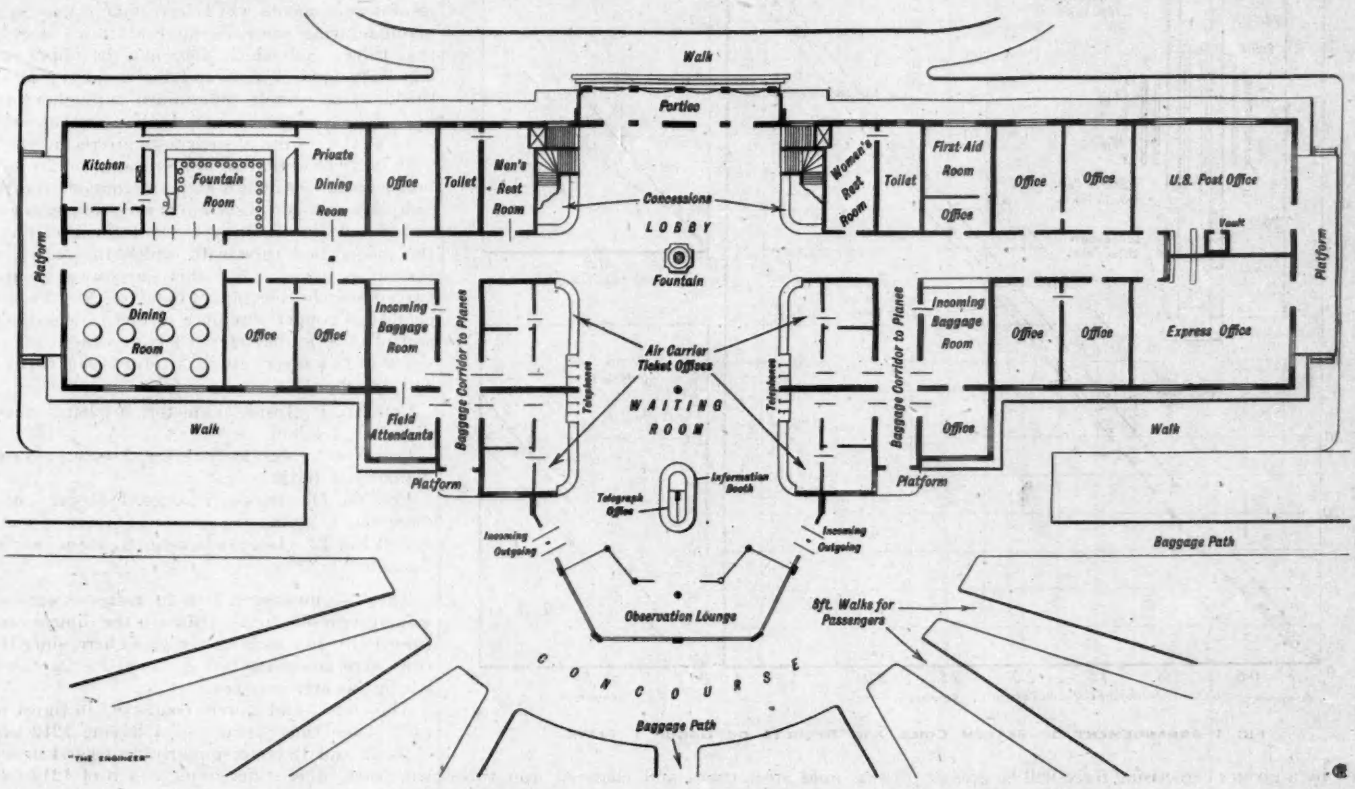


FIG. 6—SUGGESTED DESIGN FOR TERMINAL BUILDING AT LARGE AIRPORT

AN ELECTRIC THICKNESS GAUGE.—A new electric gauge for measuring the wall thickness of the hollow part of the light alloy blades of airscrews has been described recently in *Canadian Aviation*. This instrument, which has been developed by the General Electric Company of America, is capable of measuring the thickness of any non-magnetic metal even if only one side of it is accessible. Thicknesses of up to 1½in. can be measured, it is claimed, with an accuracy of about 5 per cent. The device consists of a bridge circuit, voltage-amplifying equipment, and an indicating instrument. When one of the two inductances of the bridge circuit is put in contact with the metal to be measured, the impedance is altered by eddy currents, and the balance of the bridge disturbed. This effect is proportional to the thickness of the metal.

Magnetic Penetration

By T. F. WALL, D.Sc., D.Eng.

IN previous articles* experimental evidence has been given which supports the view that the magnetisation of a ferro-magnetic material is initiated at the surface and penetrates inwards by means of a chain-like effect. One result of such a process is that the magnetic induction in the material at the surface layers will be greater than that for the lower layers, and will become progressively less towards the central part or core of the material. This effect further implies that the apparent value of the magnetic flux which is produced by a given magnetising force will be greater for a sample of which the cross section is relatively small than for a sample for which the cross section is relatively large, or, otherwise stated, for a given magnetising force the total magnetic flux for a given cross-sectional area will be greater for a sample of which the perimeter is large than for a sample of which the perimeter is small, and this will be the case notwithstanding the fact that the two samples are identical in quality (*e.g.*, heat treatment and other physical characteristics).

A practical consequence of this result is that the magnetic quality of a material cannot be completely defined from test data unless the dimensions of the sample as regards its cross-sectional area are also taken into account. It is to be observed here that this type of "skin effect" has no relationship to the well-known skin effect due to eddy currents which are developed when magnetisation is performed by means of an alternating current.

For the investigation of this view of the process of magnetisation, samples in the form of cold-drawn mild steel tubes and charcoal iron tubes respectively are particularly suitable, and in previous articles the results of some tests on such samples have been recorded. Further tests have been carried out on these tubes, and the later tests have included measurements of the "self-demagnetising" action of the magnetic poles of the specimen, this action being known generally as "end effect."

According to the classical theory of magnetisation, if a straight steel tube is placed in a long solenoid and magnetised by means of direct current the magnetic force due to the free poles at or near the ends of the tube should be the same at a point inside the tube as at a point near the surface outside the tube. For example, if a plane be considered which is perpendicular to the axis and which passes through the centre of the tube, the magnetic force due to the free poles at or near the ends of the tube will, according to the classical theory, have the same magnitude at any point in this plane, whether inside the bore or just outside the surface of the tube or at a point which is embedded in the body of the magnetised steel itself.

So far as the writer is aware, however, no experimental evidence has ever been advanced in support of that view, and it is not easy to understand how such an interpretation of the end effect can be reconciled with the known physical facts. Although it is difficult to see how any satisfactory practicable method of investigation could be carried out in so far as tests of the condition at places embedded in the steel itself are concerned, yet in the case of a tubular sample it is feasible to compare the end effect for points just outside the surface of the tube and points in the bore. Such tests have become a practical possibility by reason of the great technical developments which have taken place in the manufacturing processes for cold-drawn steel and iron tubes, and which may now be obtained of relatively great length and for a variety of wall thickness accurately maintained throughout to a high degree of precision. In the present article some of the results of such tests are recorded.

In order to obtain accurate measurements of the magnetic field strength at points outside the tube sample, a search coil system is necessary which will not include in the measurement the iron flux in the magnetised tube with which the search coil system is linked. For this purpose a group of twelve search coils was wound of No. 38 s.w.g. enamelled copper wire on a former of length 1½in. and of outside diameter 0·998in. Each coil consisted of two layers giving a total of 606 turns per coil, as follows:—

Coil No. 1: Inside diameter, 0·998in.; outside diameter, 1·028in.

Coil No. 2: Inside diameter, 1·030in.; outside diameter, 1·061in.

Coil No. 11: Inside diameter, 1·316in.; outside diameter, 1·346in.

Coil No. 12: Inside diameter, 1·348in.; outside diameter, 1·379in.

The coils numbered 3 to 10 inclusive were each wound with 606 turns, although the dimensions of these individual coils are not given here, since these coils were not connected in circuit for the tests to which this article refers.

The coils 1 and 2 were connected in series with each other, thus giving coil A having 1212 turns. Coils 11 and 12 were similarly connected in series with each other, thus giving coil B of 1212 turns. These two coils, A and B, were then connected in opposition, so that a coil system of 1212 turns was obtained which would only measure the magnitude of the cylindrical band of flux between these two coils, and this will be clear by reference to the diagram of the arrangement given in Fig. 1.

For the measurement of the flux in the core of the tubular specimen, a coil of 3373 turns was used and mounted so that it could be fixed at any desired position in the bore.

The solenoid used in these tests has been described already in a previous article,† the mag-

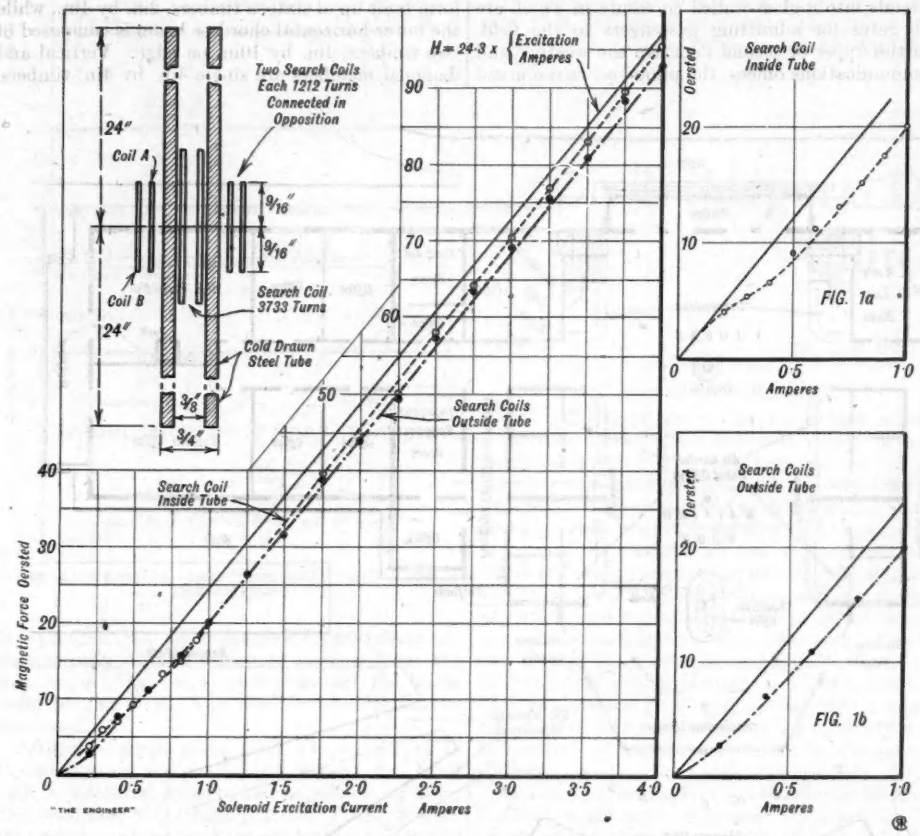


FIG. 1—ARRANGEMENT OF SEARCH COILS AND RESULTS OF GROUP I TESTS

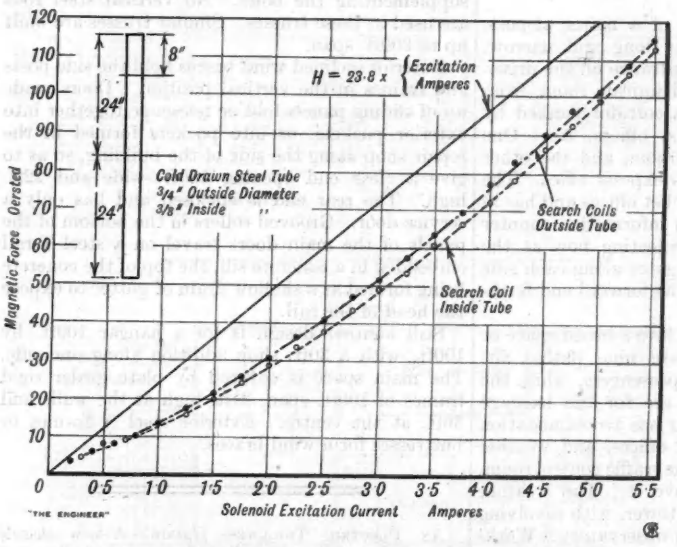


FIG. 2—RESULTS OF TESTS WITH COIL 8IN. FROM TUBE END

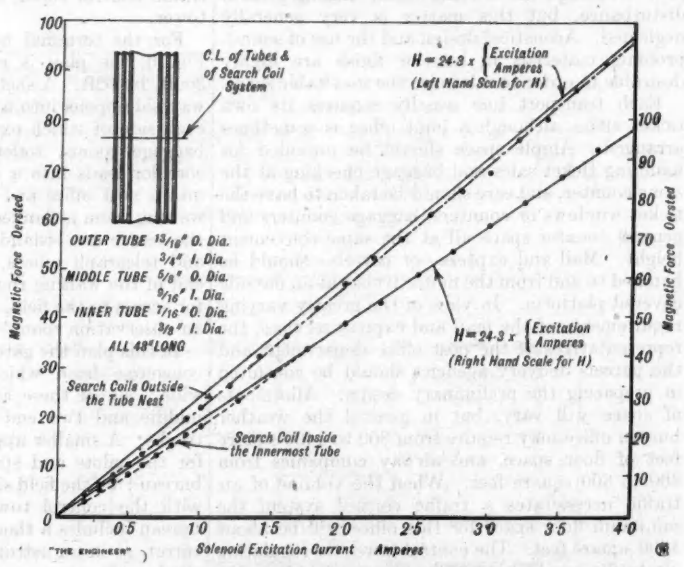

C.L. of Tubes & of Search Coil System
H = 24·3 x {Excitation Amperes (Left Hand Scale for H)
OUTER TUBE 13/16" O. Dia. 3/4" I. Dia.
MIDDLE TUBE 5/8" O. Dia. 9/16" I. Dia.
INNER TUBE 7/16" O. Dia. 3/8" I. Dia.
ALL 48" LONG
H = 24·3 x {Excitation Amperes (Right Hand Scale for H)
Search Coils Outside the Tube Nest
Search Coil Inside the Innermost Tube
Magnetic Force Oersted
Solenoid Excitation Current Amperes
"THE ENGINEER"

FIG. 3—RESULTS OF GROUP II TESTS

* See, for example, THE ENGINEER, August 13th, 1937; June 24th, 1938; April 12th, 1940. Also *Nature*, Vol. 141, 1938, page 103; Vol. 142, 1939, page 875.

† THE ENGINEER, April 12th, 1940.

netic force at the central region inside the solenoid being given by the expression

$$H = 24 \cdot 3 \times (\text{excitation amperes}) \quad \text{Oersted.}$$

Actual measurements show that the field strength inside the solenoid was constant within 1 per cent. for a distance of about 14in. on each side of the centre.

The results of two groups of tests are given in what follows :—

Group I.—A cold-drawn mild steel tube was used, of which the dimensions were as follows :—Outside diameter, $\frac{3}{4}$in.; inside diameter, $\frac{3}{8}$in.; thickness of tube wall, $\frac{3}{16}$in.; length of tube, 48in.

Group II.—Three steel tubes arranged co-axially to form a nest, the dimensions being as follows :—Outer tube : Outside diameter, $\frac{13}{16}$in.; inside diameter, $\frac{3}{4}$in. Middle tube : Outside diameter, $\frac{5}{8}$in.; inside diameter, $\frac{9}{16}$in. Inside tube : Outside diameter, $\frac{7}{16}$in.; inside diameter, $\frac{3}{8}$in.

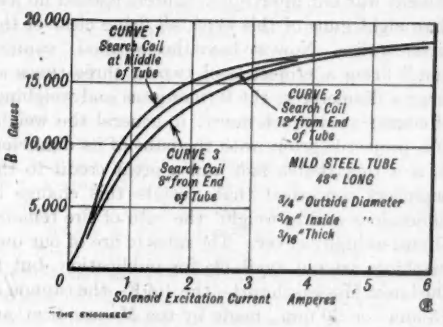


FIG. 4—MAGNETISATION CURVES

The thickness of the tube wall was thus $^1/_{32}$in. in each case, and each tube was 48in. long. This same group of tubes was used for the tests which have been described already in a previous article.‡

GROUP I.—TEST RESULTS

(*a*) The tube was arranged centrally in the solenoid and the concentric search coil system of 1212 turns was fixed coaxially with the tube and having its centre line coincident with the centre line of the tube, as shown in the sketch inset in Fig. 1. This sketch also shows the coil of 3373 turns in position in the bore of the tube.

Ballistic measurements were then made for a series of solenoid excitation currents up to about 5 amperes, the steel tube being in position shown in Fig. 1. Corresponding tests were then made with the search coil system alone in the same position relative to the solenoid, the tube having been removed. With the tube removed the ballistic readings gave a straight line relationship between the solenoid excitation and the magnetic force as expressed by the relationship

$$H = 24 \cdot 3 \times (\text{excitation amperes}) \quad \text{Oersted.}$$

The results obtained in this way are given in Fig. 1, from which it will be seen that the diminution of magnetic intensity outside the tube, due to the presence of the tube in the solenoid, increases with the magnetising current up to about 1 ampere, and for all values of the exciting current greater than about 1 ampere the diminution of magnetic intensity remains practically constant. The magnitude of this reduction of the magnetic intensity outside the tube is about 4 oersted for all values of the magnetising current which are greater than about 1 ampere.

The results for the search coil which is set in the bore of the tube are, however, of quite a different character from those obtained by means of the search coil system outside the tube. For small values of the exciting current the reduction of magnetic intensity in the bore is very small. The magnitudes for the outside and the inside of the tube for low values of the exciting current can be compared by reference to the two separate diagrams Fig. 1 (*a*) and 1 (*b*). It will be noticed, as has been stated already, that for low values of the exciting current the diminution of the magnetic force inside the tube is relatively very small. For exciting currents greater than about 0·2 ampere the diminution of magnetic force inside the tube becomes rapidly greater, so that for a current of about 0·6 ampere the magnetic force inside the tube is less than that outside. Further increase of the exciting current causes the magnetic force inside the tube to become greater than that outside until for large values of the exciting current the force inside the tube tends to become identical with the value defined by the straight line relationship,

$$H = 24 \cdot 3 \times (\text{excitation amperes}) \quad \text{Oersted.}$$

When saturation of the tube is reached the force inside the bore becomes practically the same as it would be if the tube were to be removed altogether.

It is important to observe, therefore, that on the one hand, when the magnetisation of the tube is small and, on the other hand, when the tube is magnetised to saturation, the force in the bore is practically the same as it would be if the tube were to be removed altogether from the solenoid. In other words, it may be said that the steel tube is "magnetically porous" for the two following conditions, viz. (i) when the steel is completely demagnetised, and (ii) when the steel is magnetised to saturation in the direction of its axis.

The magnetisation curve for the tube as obtained by means of a search coil wound directly on the middle portion is shown by curve 1 in Fig.4.

(*b*) In order further to contrast the magnetic force outside the tube with that in the bore, tests were made with the search coil system set at 12in. from one end of the tube and the results of these tests are shown in Fig. 5. The magnetisation characteristic of the tube as obtained by means of a search coil wound at a distance of 12in. from the end is shown by curve 2, Fig. 4. It will be seen from Fig. 5 that the magnetic force inside the tube in this case is greater than that outside the tube for the whole range of exciting currents.

(*c*) Similar tests were also made with the search coil system set at a distance of 8in. from the end of the tube and the results of these tests are shown in Fig. 2, from which it is seen that the magnetic force inside the tube is now less than that outside, for the whole range of magnetising currents. The corresponding magnetisation characteristic is shown by curve 3 in Fig. 2.

GROUP II.—TEST RESULTS

For the second group of tests three steel tubes were arranged coaxially as already explained and the tests were carried out in a precisely similar manner to that already explained with reference to Group I, except that in this case the tests only refer to the condition with the search coil system set at the middle portion of the nest of tubes. The results of these tests are shown in Fig. 3. For the purpose of clarity in presentation, two separate ordinate scales are provided for the magnetic intensity, viz., the one on the right-hand side of the diagram refers to the search coil in the bore of the tube and the scale on the left-hand side refers to the search coil system outside the tube nest. It will be seen in this case that for values of the exciting current which are greater than about 1·75 amperes the magnetic intensity in the bore of the inner tube is exactly the same as though the nest of tubes had been removed altogether from the solenoid, whilst the magnetic intensity outside the nest of tubes is reduced by the presence of the tubes in the solenoid, and this reduction obtains for the whole range of exciting currents used.

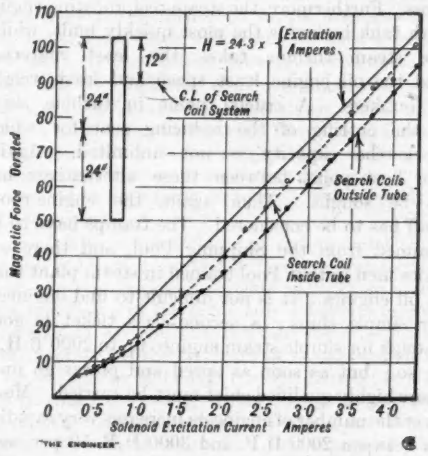


FIG. 5—RESULTS OF TESTS WITH SEARCH COIL 12IN. FROM TUBE END

The conception of "magnetic porosity," as referred to in the foregoing, provides a reasonable explanation of these effects and is in accord with the view that magnetisation is initiated at the surface of a ferro-magnetic substance and penetrates from the surface into the body of the material. From what has been said already it will be seen that the magnetic porosity is a maximum when the magnetic permeability is a minimum.

There is another aspect of these tests to which reference may be conveniently made here. It is universally assumed that in all such tests on ferro-magnetic substances the structure of the magnetic field due to a ferro-magnetic body is of the same nature as that due to a current which is flowing in a solenoid winding. It is to be observed, however, that the magnetic field of a ferro-magnetic substance is due to a system of unbalanced electron spins, the electrons revolving in orbits within the atoms of the substance. On the other hand, the magnetic field due to a current flowing in a solenoid winding is produced by spinning electrons which are revolving in the circular path defined by the diameter of the coil winding. The ballistic test in each case gives the aggregate value of the flux linkages with the respective search coils, but it is open to question whether the assumption is justifiable that the ferro-magnetic field is otherwise identical in structure with the relatively simple condition defined by a current flowing in a solenoid winding.

‡ THE ENGINEER, April 12th, 1940.

THE NEWCOMEN SOCIETY

SYLLABUS OF MEETINGS IN GREAT BRITAIN, 1941–42

October 8th, 1941.—"Automobiles in 1830," by Sydney Withington, M. Am. S.M.E., member; "Evaporation in the Sugar Industry, 1812–80," by Noel Deerr, F.C.G.I., F.I.C.

November 12th.—Annual general meeting; Presidential Address, Colonel C. E. Davies, Sec. Am. S.M.E.; "Suffolk Windmills: Part I, Post Mills," by Rex Wailes, M.I. Mech. E., Member of Council.

December 10th.—"Origin and Manufacture of Wood Screws," by H. W. Dickinson, D.Eng., Past-President; "History of Spring Balances," by W. A. Benton, F. Ph. S., member.

January 14th, 1942.—"The Normands of Havre, Shipbuilders and Engineers," by Engineer-Captain E. C. Smith, O.B.E., R.N., Past-President; "The Evolution of Rider Planes for Aircraft," by A. P. Thurston, D.Sc., M.I. Mech. E., F.R. Ae. S., Member of Council.

February 11th.—"Early Engineering and Iron-founding in Cornwall," by Rhys Jenkins, M.I. Mech. E., Past-President; "Development of Mechanism in China," by Herbert Chatley, D.Sc., M. Inst. C.E., member.

March 11th.—"The French Civil Engineers of the Eighteenth Century," by S. B. Hamilton, M.Sc., M.I. Struct. E., Member of Council; "Robert Stuart Meikleham," by H. W. Dickinson, D.Eng., Past-President, and A. A. Gomme, M.B.E., Member of Council.

April 22nd.—"Sketch of the History of Natural Draught Furnaces," by J. N. Goldsmith, M.Sc., member, and E. W. Hulme, B.A., Member of Council; "Joseph Bramah and His Inventions," by H. W. Dickinson, D.Eng., Past-President.

London meetings, which are Ordinary unless otherwise stated, take place on Wednesdays at 2.30 p.m. Places of meeting and any alterations in this syllabus will be announced in due course.

TECHNICAL ABILITY WASTED

SCIENTIFIC ability is being wasted through lack of technical co-operation between large firms engaged on Government contracts. Frequently production is held up in one factory while its technical staff overcomes difficulties already surmounted by parallel organisations engaged on similar work. Many technical men eager to help the war effort find their time wasted in trying to discover the trade secrets of rival firms. Red tape even prevents technicians in one department discussing their problems with those in other departments in the same factory. These points were emphasised in reports submitted to a delegate conference of engineers and scientists from engineering and aircraft firms which was held in Birmingham last Sunday, September 7th, under the auspices of the Association of Scientific Workers. A call was made for centralised co-ordination of technical and scientific research and development and for real pooling of information and facilities, between Government Departments, between manufacturers and between Government Departments and manufacturers. The maximum war effort cannot be made by technical staff which feels itself to be exploited by payment of salaries lower than those of skilled or even unskilled workmen under its supervision. The Association's records show that many engineers qualifying after three years' full-time study at a university at no small expense to themselves find that they are unable to earn more than £3 per week. Strong exception was taken to the system under which university graduates rated as student apprentices are put on production work and paid a purely nominal salary. It was agreed that the Association should press for minimum starting salaries of £250 exclusive of war bonus.

The Engineer

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THE SPEED OF TRAMPS

IT is to be supposed that they are called tramps because they wander about the seas from port to port without any defined schedule. That is perhaps not quite fair to the tramp of the roads, who is understood to be a man of regular, if deplorable, habits. The tramp of the oceans differs, too, from the tramp of the highway, whose main and romantic vocation is the avoidance of work. But in one respect at least they are alike, both of them are slow and for the same reason—that it is economic. The tramp of the highways has found that three miles an hour or so is a rate at which he can keep going on and on indefinitely without tiring himself out and with little wear and tear on his constitution. The tramp of the seas has settled down into a traditional speed of eight to ten knots. It can keep on slogging away at that rate indefinitely, often with a scratch crew, with very simple engines and boilers, and such fuel as it can pick up. It was the simplicity of the old-fashioned tramp steamer that made it what it was; the invaluable tweenie-maid who undertook jobs that were beneath the attentions of the upper servants, the merchantmen and great cargo ships that sail from port to port by a regular time table and on fixed routes.

The war has changed the life of the sea tramp. It is no longer an independent vagabond—in no derogatory sense—wandering where it will, but has to conform to the orders of authority, and has to sail in convoy. It was never intended for that kind of life, and many people are now calling it quite frankly a confounded nuisance and urging that it should not be perpetuated. The substance of their complaint is that since a convoy can only move at the speed of its slowest unit the tramp keeps down the speed of the convoy as a whole, so it is averred, to no more than five knots. At this speed any of the ships in the convoy, including those capable of doing much better, can be dogged even by submerged U-boats, and, of course, are easier to attack from the air. That admirable body, the Select Committee on National Expenditure, brought the matter to a head in its twentieth report, in which it not only criticised the work of the Merchant Shipbuilding Department of the Admiralty for not taking more consultation with shipowners, but questioned the type of boilers ordered and discussed, very briefly, "the speed chosen for merchant ships." It is very doubtful if such technical matters come within the competency of a committee of laymen, and many will be disposed to say that the Admiralty, which alone is in possession of all the facts about convoying, must know better than anyone else, even than shipowners, what type of ship most nearly satisfies a number of conflicting factors. There is no reason to doubt that the Merchant Shipbuilding Department would rejoice if all its ships could be given a speed of not less than sixteen knots and that a much lower speed has been adopted under the pressure of circumstances. In broad outline it may be said that the end arrived at is the carriage of the greatest quantity of goods in a given time. Now, it is obvious that too slow a speed will limit the number of voyages made, but against that there is the fact that it takes much longer to build and engine fast ships than slow ships. One has to look for the point at which, so to speak, the two lines cross. Furthermore, the steam reciprocating engine with tank boilers is the most quickly built, whilst the steam turbine takes the least material, and the oil engine least space and least weight in bunkers. A crucial point in turbine ships is the cutting of the reducing gear for which work the capacity is not unlimited. Again, the best point between these alternatives has to be sought. Then again, the engine-room staff has to be considered. The tramps have to be manned from the Shipping Pool, and there are more men in that Pool trained in steam plant than in oil engines. It is not difficult to find engineers for simple ships; a second-class ticket is good enough for simple steam engines up to 2000 B.H.P. or so; but as soon as speed and power go up a more highly qualified chief must be carried. Moreover the number of engineers increases very rapidly; as between 2000 H.P. and 3000 H.P. 50 per cent. more men are needed for the higher power. The Admiralty has to consider the supply of men, not only for the merchant ships, that are in service already or are being built here, but for the large, the very large, number that is coming to us from the United States. Finally, there is the question of fuel. Broadly speaking, it may be said that oil is more readily and generally obtainable than coal, for although the consumption of coal for bunkering steamers in home ports is trifling—it was less than 5 per cent. of all the coal raised in this country before the war—there is not only difficulty at home, but supplies have to be built up at foreign ports.

It will be seen from this all too brief *résumé* of the pros and cons that the best speed to adopt for tramps and standard ships cannot be settled off-hand in compliance with the natural desire to build ships that would be fast enough to make frequent journeys, to elude submarines, and dodge bombers. The Merchant Shipbuilding and Repairing Department has had to decide between building a few fairly fast ships with first-class engineers and a much greater number of slower ships for which less well-trained engineers are adequate. On top of all that, tactical questions, on which the Navy is most competent to speak, have to be considered. Even a slow convoy of many small and cheap ships, with cargoes distributed over many units, may give less anxiety to the escorts of protecting ships and aeroplanes than a faster convoy, every unit of which is of much greater total value. In view of all these considerations and in the lack of many facts which cannot be revealed, it would be unsafe to declare categorically that the decision of the Merchant Shipbuilding Department of the Admiralty is wrong. Perhaps one should say of it: "'Tis true, 'tis pity and pity 'tis 'tis true."

Aerial Gunnery

THE gun power carried by aircraft is steadily increasing. In the last war fighting aircraft were usually content with one or two weapons converted or adapted from the ordinary machine guns used by the armies. Even in the initial stages of the present war our interceptor fighters carried no less than eight guns of this type, all firing clear of the airscrew disc. Now we have the so-called "cannon gun," firing a projectile of two or three times as large a diameter as the former guns and weighing, of course, very much more; in general the weight of a projectile grows with the cube of its diameter. It is a remarkable fact and a great credit to the engineers concerned that, despite this change in dimensions and in weight, the rate of fire remains almost as high as ever. The rates of fire of our own machines are not available for publication, but in the latest Messerschmitt—the 109F—the cannon of 15 mm. or 20 mm., made by the Mauser firm, are found by the examination of captured aircraft to be capable of nearly 800 rounds per minute, not so far short of the rate of fire of the ordinary machine gun. Since only a limited total weight of ammunition can be carried, the length of the time of firing is much reduced, being, it is reported, less than that needed for a quarter of a minute's fire.

For a fighter to have to return to its base for fresh ammunition after as short a fight as this may seem strange, but really it is not so. With an engagement beginning at 500 yards the time for a modern fighter to close on its target may be no more than three seconds, in which case several such attacks can be made before all the ammunition is fired away. During these three seconds no less than forty rounds could have been fired at the enemy, any one of which might prove lethal. Although most of the vital parts of aircraft are armoured nowadays, it is difficult to carry enough thickness to keep out cannon shell, and the fuel tanks specially are difficult to protect. The odd thing about such tanks is that it is the exit and not the entrance of the projectile that does most of the damage. This is as true of the ordinary machine gun bullet as of any other. The damage inside the tank is largely caused by the intense compression wave which the entrance of the bullet creates, aided, no doubt, by its subsequent sideways motion. In flight through the air the gyroscopic forces due to the high speed of rotation produced by the rifling of the gun barrel are easily able to overcome the yawing tendency due to the preference which any more or less cylindrical body has for broadside movement in a resisting medium. But when the fuel tank is entered the resistance offered by the liquid is 700 times as great as that offered by the air (at sea level and still more at altitude); this leads to the gyro stabilising forces being overwhelmed and the bullet turns sideways. Sometimes it is even stripped of its sheath. This was discovered in the last war, and in the years since inventors have been quick to produce tanks effectively capable of meeting the situation, not so much by resisting the bullet or the pressure wave it produces as by the ingenious self-sealing properties of the tank walls. These inventors, or their successors, have since had to deal with the more difficult task of guarding the tanks against cannon fire. If guns continue to grow in size the problem will become still more complex, but the tendency to produce larger guns must always find its balance in the fewer and fewer rounds of the larger-sized ammunition that can be carried by the fighter. It is a path which cannot be pursued indefinitely.

Ample experience in the last war showed the value of accurate and efficient gun sights and still more the importance of their careful maintenance and painstaking use. The pilots who had the greatest number of enemy aircraft to their credit were

those who took the greatest pains with their training as accurate marksmen, and we cannot doubt that this is again proving to be the case, especially since the decrease in the number of rounds carried makes accurate aim of greater consequence than ever before. We have good reason to feel confident that our new fighters will surpass in quality anything the enemy can produce, and we have every confidence in the quality of the fighter pilots produced both here and in the Dominions—and one may add, in America—to meet the very best that the *Luftwaffe* can provide.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"PEACE AIMS"

SIR,—"Who will help?" Those words at the end of Colonel Kitson Clark's most interesting article, entitled "War Aims," caused me to keep that issue of THE ENGINEER on my desk for some weeks. He had dealt with a subject to which I, like many engineers, had given considerable thought. I had some idea that I could assist in the solution, but time passed and no action was taken.

His second article, "The World We Hope to Live In," has spurred me on to try to express some thoughts on this vast and important subject. At the end he names a dozen headings for consideration which cover the whole economic situation. It is suggested that some of these dozen require detailed consideration and that a solution of those would be found to have resolved the remainder.

The key items are Nos. 3, 4 and 6, here repeated for convenience:—

3. The control of the issue of money and credit.
4. The attitude and power of the banks.
6. The possible use of the credit of the nation.

All the other items are results arising from some basic error in the financial system to which all the three are closely related. These all hinge upon the basic question which is now, at long last, arising in the minds of people generally: "Where does the money come from?"

The man in the street and his wife in the queue are saying that, if money to the extent needed for the war can be found now, then in that happy future when the war is over they will never believe that money cannot be found for the betterment of social conditions.

Now that man and his wife do not understand anything of the present financial system. Even many engineers, in spite of their logical training as to cause and effect, are equally ignorant. But the engineers for that very reason are just the class who should understand the situation and not be sidetracked by the suggestion that finance is a complicated question—that it should be left to the experts, the bankers and the financial houses.

More and more people are now aware that the greater part of the money or moneys equivalent that we possess owes its origin to the bank. Thus in a late return the total deposits in the London Clearing House banks were £2976 millions, and against this the banks only had coin and credits at the Bank of England—regarded as the equivalent of cash—amounting to £311 millions. The one-time orthodox explanation of the bankers was that they had used the difference in making short-term loans to other clients and in making investments. Few now maintain seriously that bankers lend their depositors' money and the candid ones admit that bank advances to clients or purchases of stocks and shares are the cause of the increase in deposits.

A banker making a loan to a client credits the client's account with the amount, but does not debit any other account with this sum. Thus the total amount of the deposits is increased. Investment by the banks has the same effect. The Government is the largest borrower from the banks, and this is the main cause of the recent increase in deposits.

A comparison of the bank's position at June 30th last and a year ago shows the relation between deposits, advances (private and Government), and investments, the figures being in millions of pounds:—

	June 30th, 1940. £	June 30th, 1941. £	Change. £	
Deposits	2469	2946	+477	
Advances to customers ...	962	859	−103	+£432
Treasury deposit receipts...	—	482	+482	
Bills discounted...	384	193	−191	
Investments	636	880	+244	

This creation of credit by the banks is almost costless. It involves some clerical work, entailing staff, and their accommodation, but the total cost is not sufficient to justify even the smaller interest that is usual in this war than in the last one.

It is very doubtful whether the banks are really entitled to anything more than their actual costs plus, as has not always been the case in engineering contracts, their fair overheads and a reasonable profit. For it must be noted that if the banks lend £100 and require £x as interest before repayment they are taking from the community £$(100+x)$, but have only provided £100. The biggest reservoirs will empty in time if the discharge exceeds the supply.

So much for interest. But there is a worse feature in the ultimate repayment of the loan. The Government, in collecting funds for redemption, has to tax its nationals, so depriving them of their freedom to spend their own earnings. Thus all undertakings, originally financed by loans, have ultimately to be paid for out of income *vid* taxes or savings. This applies to the shares in such undertakings held by individuals and, indeed, by any concern other than those who have been allowed to assume the sole right of credit creation.

What a drain on the wage and salary earner the payment of interest alone can be is shown by the fact that since 1918 this country has paid £6,000,000,000 in interest alone and so our debt remains as our Old Man of the Sea. It had become a permanent liability, binding us in perpetuity to the bankers. The present war is increasing it. From March 31st, 1940, to June 30th, 1941, the floating (*i.e.*, unfunded) debt has increased by no less than £1574 millions.

The banks are prepared to advance unlimited sums to the British Government because their credit is good, because they are deemed good for the interest—the bank would very much dislike all the debt repaid, but wishes to receive interest without interruption.

Now, the very fact that the Government credit is good is the reason why the Government should not go to the bank for credit or cash. They should themselves create the credit necessary for the well-being of the country, whether in wartime or in peace. Then there would be no interest to be paid, and no repayment of any loan.

Colonel Kitson Clark refers to one proposal and dismisses it briefly regarding it "as if it was tantamount to a repudiation of obligations." There need be no repudiaton of the debts now nominally owing to the financial system, although there are precedents for such action. If the Government would take over the issue of money and credit (Colonel Kitson Clark's third heading), the country could manage to pay off the existing indebtedness in a fairly short time, although it could be maintained that repayment in full would not be justified.

Whilst the present economic system is believed to be the main cause of much of our troubles and the cause of the so-called inevitable cycles of slumps and booms, no charge is made against any of those whose function it is to administer the system. It has gradually grown to its present form. Initially it worked fairly well, but when an engineer made mechanical power available to supplement the producers' muscles, at that moment the financial system started to assume a position inimical to the well-being of the nation.

This leads to other headings of Colonel Kitson Clark, particularly No. 2, "Share by employees in reward."

When every process in the manufacture of any article was done by hand, by a craftsman often working on his own, the total of the cost of materials plus the craftsman's living expenses or cost of wages if hired represented the whole of the cost of the product. Such is not the case now. Over and above materials and labour, including in the latter both direct and indirect, to the fullest possible extent, there has to be a considerable addition made before the total cost is ascertained. Of this extra addition included in the price, a large portion is not distributed to any one as wages or salary and so is not available in anyone's pockets to purchase the products of industry. It should be noted that if P supplies material to Q, when Q pays P for it, P at once uses the money to repay the bank if working on an overdraft, or to reinstate his credit balance so that he may commence another cycle of production. He has, previous to the sale of the material to Q, paid his employees for their services in producing the material. When, therefore, Q puts the finished article on the market, the wages distributed by P are no longer available for purchasing goods. Hence a serious shortage of purchasing power arises from the production of all articles and as a result we have reached the stage when selling an article is much more difficult than producing it. This is generally recognised. Are not salesmen paid higher salaries than producing engineers?

There are two cases in which P and Q could continue at work without great financial worry. They are:—

(i) If the banks would renew all loans automatically and P and Q were able to produce at a steady rate; and

(ii) If some of the Q firms were producing goods which were not for re-sale and so did not compete for a share in the deficient purchasing power.

The second of these cases is under way now. We are all producing munitions of various sorts which are not for sale; on the contrary they are given away. This involves the disbursement of large sums in wages, which, by supplementing the wages distributed by the Qs making consumable personal goods, enables all these goods to be bought. This effect is so pronounced now that the position of both P and Q is better than under the first case. They are able to repay the advances received from the banks. This is shown by figures quoted earlier, the advances having been reduced by £103 millions in twelve months.

The munition wages distribution is so great and the output of consumable personal goods has been so reduced that inflation appeared to be a possibility. This has been well countered by heavy taxation and by the savings movement.

This action to avoid inflation is quite in line with the ideas of the orthodox economists, but they would not follow an equally reasonable line of conduct when munitions are no longer to be produced in astronomical quantities. They are now adjusting our purchasing power to the smaller amount of goods that are available. After the war there will be less purchasing power under the present system, but far more consumable personal goods and therefore, to be logical, the purchasing power at our disposal should be augmented so that the available goods can be purchased or distributed unless a policy of restriction be adopted with a lowering of the standard of living.

The function of money is really to facilitate the transfer of goods from producer to consumer, just as railway trucks are provided for the transport of merchandise. A railway company provides the number of trucks needed for the goods to be moved and similarly the amount of money should be adequate to distribute the products of farm and factory. No railway would, as a permanent policy, restrict the goods conveyed to the trucks they initially had, but would increase the number of trucks as more goods required conveyance.

But the amount of money, the conveyor from producer to consumer, is determined by the financial system's masters, and, one suspects, not always in phase with the real needs of the community at large.

Even to indicate all the evils arising from this ability of private trading concerns to control the amount of credit available would occupy too much space. Such control implies absolute power and exceeds any authority possessed by Governments and Parliaments. The control of the volume of credit should be in the hands of the Government, or rather of a body of a judicial nature, not subject to the whims and fancies of political parties. It is not a political question and must be above and beyond party politics.

With a National Credit Office in control of credit creation—and the name "National Credit" is used because all is based upon the credit worthiness of our nationals—they would ascertain by strict actuarial methods, which would be approved by accountants, the amount of money needed to equate purchasing power to purchasable products. This sum would then be used by paying some sum periodically to all nationals, or to all above a certain age or to those determined in some acceptable manner. As to whether there should be any discrimination as to age, income, character, &c., much would be said, but space forbids.

When it is appreciated that credit creation for the purpose of war is on a scale comparable to the whole national pre-war income, it will be seen that, provided sufficient goods are produced, the amount of money or credit available for distribution may be a considerable percentage of pre-war personal incomes. To those with comfortable incomes or salaries, an equal share in this distribution will not count for much, but for those millions who were, in pre-war

days, hovering about the subsistence level, this same equal share would be a godsend.

No longer then would a person have to work at low wages in uncongenial surroundings. The employer would have to continue the improvements in the shops to which Colonel Kitson Clark refers in his review of fifty-two years. Further, unemployment would no longer be a bogey, ever tormenting the workman in peacetime. If there were no employment he would have his national dividend which would provide essentials and would maintain his self-respect, a most important gain.

In his first article Colonel Kitson Clark said that the gardener's son wished to have "constant employment and good enough wages." The latter portion has been considered, but can any employer guarantee constant employment or does any employee really want it. Is there not a time when the most active of us begin to think that it would be pleasant not to have to start work every day at the same time, when we would like to devote time to hobbies, to culture, both material and spiritual? Does not the gardener's son's dual wish come down to the single one of "good enough wages," as he, like most people, cannot conceive of "good enough wages" without employment.

Due to space limitations it is not possible to deal with many criticisms that will be made. One of the first will be that it is wrong to pay money except for work done, as it will demoralise the recipients. How many people have we known who have refused a legacy on the score that its acceptance would undermine their characters? I have yet to meet the first one.

Every employer, every engineer is always trying to get a greater output from a given number of men by using machinery more and more automatic, more and more ingenious. To maintain that without work it is wrong to receive money and at the same time to reduce to a minimum the opportunities of work is hardly consistent and certainly not Christian.

Of many aspects of this vast and most important question, no detailed proposals can be outlined here. Its effect upon export trade is most important. Colonel Kitson Clark quotes one sentence which is only too true: "Competition between nations involves dangers of international complication which lead to war." Export competition leads to war. But will there not be less export trade after this war. The last war saw a great impetus to manufacturing in our Dominions and in countries previously regarded as non-industrial. In this war that movement will progress more rapidly. When Australia, Canada and India are producing the most complicated machines, such as tanks and aeroplanes, are they not to be expected to produce the more useful and simple requirements of a peaceful life?

Hence a new attitude towards export trade must inevitably develop. But the home market offers great possibilities as we must agree that all were not enjoying, before the war, a standard of living which would be acceptable to the more fortunate members of the community. Examples of great industries which have arisen since Colonel Kitson Clark started in the shops and which have provided services now regarded as necessities are to be seen in the cycle and motor-car trades, the gramophone and radio and rayon businesses. And there will be others to follow, all rendered possible by the mechanical ability of the engineer, together with his physical and chemical *confrères*.

But when the initial equipment and supply of these one-time luxuries but present necessities has been made, and when the war damage has been repaired, there may not be work and employment for all. Is that really a cause for discontent? Are we not all trying to use more machines and reduce the time for all operations from typewriters and calculating machines in the offices to batches of automatic or semi-automatics in the shops?

Eventually all will have more time for self-culture and education, for which there is little time now. It is admitted that vast numbers now would not know how to spend usefully any greater leisure time, but that would be overcome in time. The last century has seen a wonderful improvement in the ideas and habits of the masses and why should not this improvement continue? It must do so.

One more point. It has been said that the ideas which it has been attempted to indicate here are not practicable until all industrial countries act similarly. That is not correct. Any country that is autonomous can decide these matters for themselves. Great Britain is a sufficiently large unit to establish this new idea and those who wished to trade with us would adapt themselves to it. When we went off the gold standard in 1931 it was expected that we would have to pay more for all our imported commodities, but world prices were adjusted to our level so that the landed prices here remained substantially unchanged.

Great Britain has led the world for centuries in many matters and is destined to play an ever greater part in the future, both near and far. This question of financial and economic reform is one direction in which she must lead to a saner situation. In this leading there will be no trace of compulsion. We will lead by example, and so good will the result be that just as other nations adopted our parliamentary system, so will they once more follow in our footsteps. Where the democratic parliamentary system has failed, is it not due to a sense of frustration, arising from the inability of Parliament to ensure fully the well-being of their people under the falsely based economic system?

It is for that reason that it is to be hoped that engineers will interest themselves in this vital affair, as with their training of noting cause and effect, their logical attitude, they are as well as or better equipped than any other class of men to demonstrate the futility of poverty amidst plenty and the boon which labour-saving or trouble-saving machines should be to humanity. Under the present system some wonderful automatic machines have been suppressed, due to the great displacement of labour they would cause. Is this right? May the engineers follow the light out of this golden maze into that period when wealth is recognised as an ability to produce in which all men should share.

I. V. ROBINSON.

Walton-on-Thames, September 3rd.

PROBABILITY THEORY AND MENTAL CAPACITY

SIR,—Apart from its topical interest, the Twenty-second Report of the Government's Select Committee on National Expenditure has a special interest for the technically minded, or, at any rate, for those who believe with Walter Shewhart that "the basic contribution of statistics to the science of engineering is an improved scientific method to fit the world of probability in which we live." This Report, which has just been published,* deals with the allocation of man power in the Army and to this end recommends a rational application of intelligence tests, which appears to have been lacking hitherto in the drafting of men to the four Services. In the absence of objective and thus reliable data on the distribution of intelligence levels throughout new intakes into the Army the Committee has been virtually compelled to base its findings on scientifically established information published sixteen years ago by the Industrial Fatigue Research Board (in its Sixth Annual Report) relating to the adult population of this country, and this information is summarised in the accompanying table. The first three columns, taken from the Select Committee's Report, show the distribution of intelligence levels throughout the general adult population when classified into vocational categories according to a somewhat arbitrary intelligence scale. The distribution is depicted graphically in Fig. 1 (in the form of the usual frequency histogram) in which the intelligence levels are shown plotted against the relative frequencies with which they occur. Now, at a first glance there is nothing much in the histogram, or in the tabular data which it represents, to tell us whether mental capacity is distributed throughout the population in any characteristic manner. All that we can say is that the average mental ratio of the populace, corresponding to the centre of gravity of the histogram, lies somewhere between 90 and 100, and that the great majority (about 90 per cent.) have mental ratios lying in the range from 70 to 130. Is it possible to learn anything further from data of this nature other than by subjecting it to a detailed analysis whose justification lies in the realm of statistical science and whose application involves a considerable amount of time and labour? Contrary to general belief, it *is* possible to do so and, in fact, to learn a very great deal from apparently scanty data, by making use of a simple dodge which makes a ready appeal to the engineering mind.

Vocational category.	Fig. 1. Mental ratios.	Fig. 1. Per cent. of adults.	Fig. 2. Mental ratio exceeding.	Fig. 2. Per cent. of adults.
1. Highest professional and administrative work	>150	0·1	150	0·1
2. Lower professional and technical work	130–150	3·0	130	3·1
3. Clerical and highly skilled work	115–130	12·0	115	15·1
4. Skilled work. Minor commercial positions	100–115	25·9	100	41·0
5. Semi-skilled work. Poorest commercial positions	85–100	32·8	85	73·8
6. Unskilled labour and coarse manual work	70–85	19·0	70	92·8
7. Casual labour	50–70	7·0	50	99·8
8. Institutional cases (imbeciles and idiots)	<50	0·2	0	100

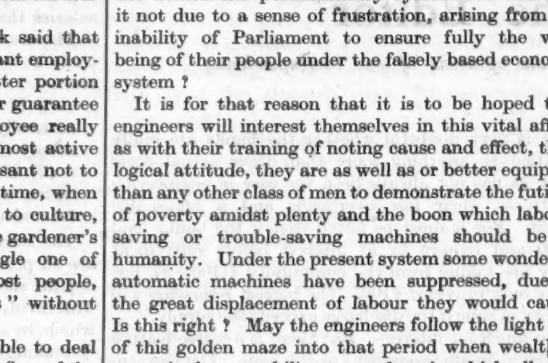

FIG. 1

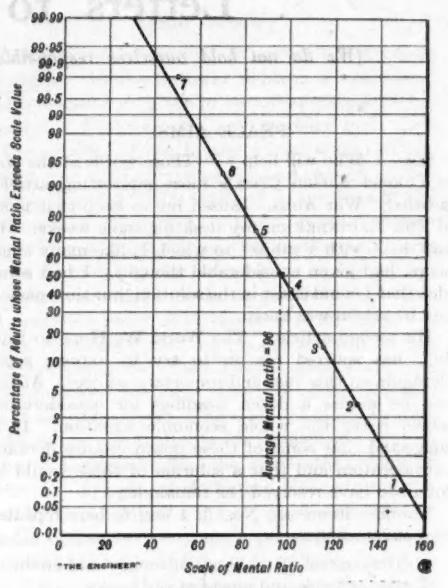
Percentage of Adults whose Mental Ratio Exceeds Scale Value
Average Mental Ratio = 96
Scale of Mental Ratio
"THE ENGINEER"

FIG. 2

In view of the statistical nature of the universe it is to be presumed that mental capacity, like height or any other such physical attribute, is distributed throughout a large population in a genuinely random manner. As engineers we are inclined to forget what a surprisingly large part of this world of ours is ruled by chance. Even the span of human life itself is governed by a constant system of chance causes; that is, a system whose effects are scientifically determinate in the sense that they are predictable in accordance with the laws of probability. To test whether the data underlying Fig. 1 obey such a law all that we need is a sheet of "probability paper." This is simply a particular kind of graph paper, ruled in such a way that data obeying the "normal law" of probability—applicable to observations of a variable which can have continuous as distinct from only discrete values—plots as a straight line. The same idea lies behind the well-known use of "log paper" for plotting data obeying an exponential law.

The last two columns of the table given above show the cumulative frequency tabulation for the data in question, and are self-explanatory. The resulting plot on probability paper is depicted in Fig. 2. It will be seen that all but the extreme points lie on a perfectly straight line giving a value of 96 for the average mental ratio, and that even these extreme points lie very close to it. Indeed, the stability of the data is quite remarkable. It is not only evident that the distribution of mental capacity in the general adult population is in accordance with the classic law of probability, but it is also clear that the population sample studied by the Industrial Fatigue Research Board in 1925 was a truly random sample. Whether the Army can be regarded as a fair sample of the general population is, of course, another matter. Such a supposition, to quote the Select Committee, whose latest Report has prompted this letter, "must be qualified by the fact that the other Services have usually had the first choice."

H. RISSIK.

Hurlingham, S.W.6, September 6th.

[Mental Ratio is Mental Age divided by Chronological Age, multiplied by 100 for convenience. Thus

* H.M. Stationery Office. Price 2d.

a boy of 14 years might show by psychological test intelligence no higher than that of a boy of 12. His mental ratio would therefore be $14 \div 12 \times 100$, say 117.—ED., THE E.]

A RISING COAL OUTPUT

SIR,—In your issue of August 15th there appears a letter from a correspondent entitled "A Rising Coal Output."

The writer first expresses the view that if each coal face worker were paid at piecework rates or according to the weight of coal he despatched to the pit's head, British miners would undoubtedly excavate more coal week by week than they had ever done before; but he adds that this popular panacea for improving output is not generally applicable to mining operations, mainly because of variations in the character of seams.

The writer can, however, be reassured on this point, since piecework is the normal method of payment of coal face workers.

He then goes on to suggest that the problem is to make advances in the wages of all colliery employees synchronise with an increased production of coal, and urges that for the assurance of a rising coal output the best assurance is rising colliery profits coupled with participation therein by all concerned.

Here again it may be pointed out that this principle lies at the root of the wage agreements operating in the coal industry. These provide that in each district period by period the net revenue remaining after the deduction of the cost of timber, stores, &c., from the proceeds from the sale of coal shall be divisible between workers and owners in agreed proportions—generally speaking, 85 per cent. and 15 per cent. respectively—effect being given to this by appropriate periodical variations in the district percentages payable on basis rates of wages. This proceeds-sharing principle was introduced twenty years ago and evoked high commendation from the then Prime Minister, the Right Hon. David Lloyd George.

The agreements necessarily provide that in no case shall the district wages percentage be allowed to fall below the agreed minimum, and it is true that over a number of years the difficult economic conditions which the coal industry experienced—particularly in the export trade—kept wages percentages at the minimum and impeded the operation of the sharing principle. To that extent there is undoubtedly point in the last paragraph of your correspondent's letter.

It is hardly possible within the limits of a letter to deal with the various factors affecting coal production in wartime conditions, but this much can be said, that both sides in the industry are co-operating with the utmost cordiality to achieve the best possible results.

W. A. LEE,
The Mining Association of Great Britain.
London, September 2nd.

"SHORTAGE OF ENGINEERS"

SIR,—I have read with very considerable interest "Young Hand's" letter under the above heading. Since 1925 I have served as a draughtsman in the drawing-offices of three prominent engineering concerns. During that time I have never known of a single case of a draughtsman being promoted to a post outside the drawing-office. What is the reason? A fully trained senior man is often very well qualified to serve in an executive position, and when one sees the abilities of many who hold such positions it certainly brings one "furiously to think."

Draughtsmen as a body could well be divided into detailers and mechanical designers. It is the latter who often deserve, but it would appear are so seldom considered worthy, to leave their boards and tee squares and fill an appointment where their accumulated knowledge would be of greater service to their employers.

ANOTHER YOUNG HAND.

ENGINEERS, THE INSTITUTIONS, AND THE GOVERNMENT

SIR,—Your Leader, under the above title, is a practical view of the present position, and there is a strong section of technical men who visualise the essential need for definite co-ordination between the scientific and technical institutions.

Education of the rising generation on economic and political matters is, however, another problem, and perhaps we are trying to move too fast in discussing the squeezing into the present solid syllabus of an entirely new section.

After the graduate has attained his degree and started out on his real job, he will then be relieved of intensive study, and will, doubtless, become a junior member of his appropriate institution.

Why not form an Economic and Political Group in each branch, as is now the practice amongst senior members? These young brains are the spearhead of our advance, and it is they who will presently form our future policies. We do not at first require a wide front, but we do want the nucleus for building the future on a sound foundation.

If such groups were formed they would attract the progressive brains, and those of the senior members who visualise the necessity for this movement could join in with their wider experience, and in the course of a very short period a powerful movement would be in action.

JOHN D. TROUP.

Purley, Surrey, September 8th.

Legal Significance of Wartime Contracts

THE sanctity of contracts is traditionally recognised in the engineering world. Those made during the present war are in many cases loosely framed to run for the "duration of the war." It is questionable, however, whether the true significance of this commonplace expression is appreciated. On it hinges contractual obligations connected with all branches of engineering, which may run into millions of pounds, and involve thousands of firms, companies, and individuals.

The expression "war period" is defined in the text of a Bill passed in Parliament this year. It is interpreted as "the period beginning with the second day of September, 1939, and ending with the date on which the Emergency Powers (Defence) Act, 1939, expires." But when this latter will be no one knows; and this is the gravamen of the matter, because it is undecisive.

Many business men and engineering firms have agreements and obligations deemed to be binding for the "duration of the war." This period is, however, indefinite, and it may therefore be opportune to recite facts which may act as finger-posts to a definite understanding as regards date, and thus avoid interminable trouble.

It may be recalled that during the 1914–18 hostilities many time limits in engineering contracts and agreements stated that they should go on for the "duration of the war." When the Armistice was declared, the question arose as to whether that should be considered the cessation of the war. It was considered so by many; others took a contrary view, and sought a decision in the Courts of Justice.

Eventually the Government fixed the war's "duration" and "termination." They were by no means satisfactory to a large body of engineering firms, but they had to be recognised. No doubt the procedure to be followed in the present war will be patterned from the precedent set in the last, for the problems involved are factually similar.

MEANING OF WAR

The meaning of war is more than a question of academic international law; it is of major importance to all engaged in engineering businesses. The practice of the Axis nations, as we know, has been to invade neighbouring states without declaring war, and contending that their action is one of non-aggression. This technique has introduced the question as to when is a nation at war. Where there has been no declaration and no breaking off of diplomatic relations, it is difficult to argue.

So far as the Empire *vis-à-vis* Germany and Italy are concerned, a proper declaration of war in accordance with The Hague Convention has been made. With the present state of international affairs, however, we have become involved with other nations without declaring war; our relations with Rumania, Bulgaria, and the poise of affairs with Vichy introduce themselves. If it be a case of "no declaration, no war," the wording in contracts and agreements may usher to the fore complications.

"DURATION" AND "TERMINATION"

As a result of being at war, there arises the necessity for a definite understanding regarding the "duration" and "termination." Actual dates would supply the factor which the engineering fraternity should insist upon.

At the conclusion of the 1914–18 hostilities the Peace Conference went through protracted stages, The Armistice was arranged for on November 11th. 1918, for thirty-six days. It was renewed on December 14th. The Peace Treaty was signed on June 28th, 1919. It had to be ratified, but this did not take place until January 20th, 1920.

Between the Armistice and the Treaty ratification several cases were fought out in the courts over the precise significance of "duration" and "termination" of the war. These expressions were used in engineering contracts and agreements (as they are being used in current contractual obligations), and the different parties to them selected dates which they averred should be recognised.

An Act of Parliament was eventually passed called "The Termination of the Present War (Definition) Act," which gave the Crown power to fix the end of the war. An Order in Council was accordingly made on February 9th, 1920, fixing the termination of the war between Great Britain and Germany as the date of the ratification of the Treaty, viz., January 20th, 1920. A further Order in Council was made in 1921, fixing the end of the war "generally."

Where lawsuits were pending, the official date for the termination of the war was accepted. Hardships and loss of money were caused by this protracted official date—fourteen months after the Armistice—as it forced obligations to a period beyond what was thought necessary.

From these facts will be seen the desirability of all engineering firms which have contracts and agreements, and engineers who have appointments in which the "duration" and "termination" of the war are recited, to know precisely their period. Something more fixable than the mere "duration" and "termination" should be stated; an accepted understanding is most desirable and should be come to. To side-track the issue is to court disaster later, while to come to a definite understanding will prevent any fear of litigation, which has a destructive influence on business relations.

Sixty Years Ago

ELECTRIC POWER

A LEADING article in our issue of September 9th, 1881, commented upon the fact that at the moment nothing save electricity was being talked about in scientific circles. The daily Press had also taken up the subject, and journals "which were nothing hitherto if not political" were indulging in "magnificent rhapsodies concerning the future of electricity." Even eminent engineers, carried away by the intoxication of the moment, were, we said, asserting that the steam engine was doomed, and that its place would be taken by the electricity engine. Amidst all the clamour, it was not easy to keep one's head clear, and mistakes might be made which would cause disappointment to many and retard the progress of electrical science. We confidently expected, we continued, that electricity would prove a potent agent in the hands of the speculator for extracting gold from the pockets of the public. We desired therefore to warn our readers in time and to clear the air of some of the mists with which it was obscured. There was, no doubt, a great future before electricity, but it was equally certain that it could never do many of the things which the half-informed could be readily made to believe it would do. We then proceeded to explain at considerable length that electricity could not originate power in the way in which coal could be used, and that it was merely a means of transmitting power from one place to another or of storing power up at one time to be used subsequently. Discussing some of the suggested uses of electricity, we dealt in particular with its employment for railway propulsion purposes, and showed that for a fifteen-coach train, running non-stop from London to Peterborough in 1 h. 40 min., 25 tons of Faure batteries would be required. Concluding, we remarked that Sir William Armstrong, Sir Frederick Bramwell, Dr. Siemens, Sir William Thomson, and many others might be excused if they were a little enthusiastic about electricity. They were for the moment overjoyed with the success they had attained. But when the time came for sober reflection they would, no doubt, see good reason to moderate their views.

COLOURED CHIPPINGS FOR ROAD DRESSINGS.—The Road Research Laboratory of the Department of Scientific and Industrial Research has issued, in co-operation with the Ministry of War Transport, the second of a series of Wartime Road Notes, entitled "Sources of Naturally Coloured Chippings in Great Britain." This note has been prepared with the collaboration of the Geological Survey and Museum to provide information on sources of supply in Great Britain of coloured chippings such as might be used for surface dressing roads and for other similar purposes. The note deals mainly with black or dark grey stones and with the darker shades of red, brown, and green. Dark grey stones are abundant in most parts of the country; red and brown tints are not uncommon; but most of the green rocks available are either too dark or too grey. As strong colours in rocks are frequently associated with weathering, it often happens that highly coloured rocks are structurally weak compared with those most suitable for surface dressing. The question of strength is not discussed, but is obviously one the engineer must consider.

Deflection of Cast Iron at High Temperatures*

By L. W. BOLTON, A.M.I. Mech. E. (British Cast Iron Research Association, Birmingham).

Introduction

Ordinary grey cast iron fails at high temperature through growth and scaling, but special irons have been developed in recent years which possess resistance to a marked extent to both these effects. The extended application of these irons in industry has made it desirable to have some information regarding their resistance to deformation under prolonged application of light loads at high temperatures.

The work described in this report was carried out with a view to supplying some of this information, and since the results of quantitative creep tests at high temperatures are extremely difficult to interpret for purposes of design, it was felt that the work should not be confined to actual creep tests on the special irons, but rather should be designed with a view to studying the influence of composition, structure, and casting conditions on this phenomenon. In this way it was hoped to obtain data on the relative resistance to deformation under load at high temperatures of various types of heat-resisting cast irons which are now available.

Most heat-resisting cast irons have a fine graphite structure, and some owe their qualities to the presence of an abnormally high silicon content, *i.e.*, more than 4·5 per cent. Others are austenitic, and consequently are far less rigid at room temperature than pearlitic or ferritic irons. It is sometimes desirable that the irons contain a moderate quantity of phosphorus in order to improve the castability of the metal. For these reasons, special attention has been given in this work to the influence of graphite size, variations in silicon and phosphorus contents, and to alloying employed to the extent of rendering the structure of the iron austenitic. Some data on carbon steels of varying carbon content have also been obtained.

For the purpose of this exploratory work, a method of testing has been developed which consists essentially of transverse loading a bar of standard dimensions at one end, while the other end is rigidly held, the stressed portion of the bar being held at a predetermined constant temperature. Details of the apparatus used and the method of carrying out the test are described below.

After consideration of the various industrial applications in which cast iron is used at high temperatures, it was decided that information was most needed on its resistance to deformation at between 800 deg. and 900 deg. Cent. A temperature of 850 deg. Cent. was therefore chosen for the investigation.

Apparatus Used and Method Employed in the Test

The lay-out of the apparatus used is shown in Fig. 1. The specimen D is a bar 7in. long and 0·6in. in diameter, reduced to 0·5in. in diameter for a distance of 1in. near one end, for the purpose of localising the stress. One end of the bar is rigidly held in a heavy heat-resisting nickel-chromium alloy holder B, clamped to the base of the apparatus by

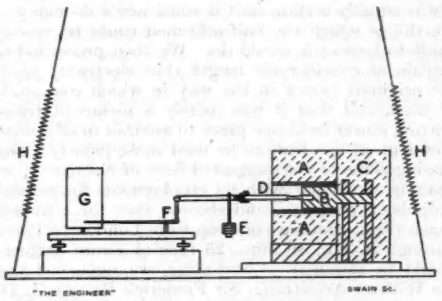

Fig. 1—*Apparatus for Examining the Rigidity of Cast Iron at Elevated Temperatures*

means of stout cast iron brackets. The test piece is loaded at the free end with weights E, and a system of levers F amplifies the movement of the pointer at the end in the ratio of 10 to 1, this movement (*i.e.*, deflection at the free end) being recorded on a moving drum G. In order to eliminate the effects of vibration, the whole apparatus is suspended on springs H. The test piece is raised to, and maintained at, the required temperature by means of a resistance furnace A, well lagged with kieselguhr. On account of the massive size of the holder B, the rest of the apparatus was also thoroughly insulated with kieselguhr and slag wool C. The temperature of the specimen was obtained by means of a platinum/platinum-10 per cent.-rhodium thermo-couple, the hot junction of which could be moved along the bar for a distance of 1in. The furnace temperature was not thermostatically controlled, but the variations in temperature did not exceed ±7 deg. Cent., and these variations were found to be without effect on the manner in which the bars deflected under load.

* Report on a research carried out with the aid of a grant from the Andrew Carnegie Research Fund, Iron and Steel Institute; received November 11th, 1940.

In carrying out the test, the furnace was slowly raised to the required temperature, and a steady temperature state was reached in approximately five hours from the time of switching on the furnace. During this heating-up period, the test bar was supported at the free end to prevent any sagging under its own weight. The weights used at the free end were such that the transverse stress at the narrowed part of the bar near the fixed end could be increased in steps of 0·1 ton per square inch from 0 to 2 tons per square inch.

The effect of applying a load at the free end of the bar was to cause a fairly rapid rate of deflection for the first three or four hours, but after this the rate of deflection gradually decreased, and then remained constant. At the end of a twenty-four-hour period the load was stepped up by an increment of 0·1 ton per square inch, which was maintained for another twenty-four hours, and this process was repeated until the bar had bent through an angle of approximately 10 deg. It is worthy of note that even the most brittle of cast irons, such as the high-silicon and high-phosphorus irons, were found to deform to this extent at 850 deg. Cent. without breaking.

The tests carried out showed that the section of the bar as cast had a considerable influence on the manner in which the test piece was deformed under load at high temperatures. It was found, for instance, that test pieces machined from thick cast sections were less rigid than those machined from thin sections of the same iron, and, in interpreting the results, this factor has to be taken into consideration.

The Influence of Silicon on the Rigidity of Cast Iron at 850 deg. Cent.

The ordinary common grey iron of medium silicon content, often used at high temperatures, usually fails ultimately from scaling and growth. Norbury and Morgan† have shown that if the graphite can be kept in a fine state of division, high-silicon cast irons

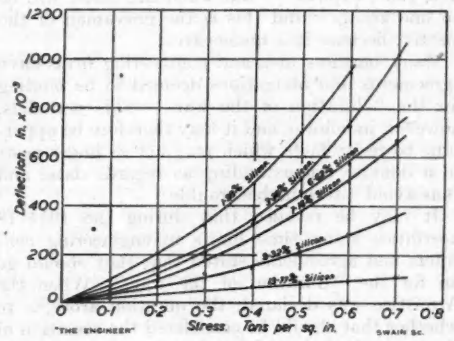

Fig. 2—*Deflection of Series A Bars at 850 deg. Cent.*

have resistance to scaling and also a marked resistance to failure from growth. Such irons, having a silicon content of approximately 5 per cent., together with a fine graphite structure, are known as Silal. The influence of additions of silicon to cast iron is well known, the matrix becoming harder and more brittle with increasing silicon. The eutectic carbon content is reduced and the high-silicon cast irons with a silicon content of 14 to 16 per cent., used at present mainly for their resistance to chemical attack, contain usually less than 1·0 per cent. of total carbon, even when melted in contact with carbon, *i.e.*, in the cupola.

A series, A, of bars with increasing silicon contents, ranging from 2 to 14 per cent., was tested, the actual compositions being given in Table I, and the results

Table I.—*Compositions of Irons, Series A (Increasing Silicon Contents)*

No.	T.C., per cent.	Si, per cent.	Mn, per cent.	S, per cent.	P, per cent.
1	3·10	1·98	1·16	0·034	0·022
2	3·33	3·28	0·75	0·019	0·067
3	2·15	6·62	1·19	0·028	0·034
4	2·67	7·16	1·17	0·031	0·031
5	1·63	9·32	1·19	0·011	0·100
6	1·07	13·77	1·09	0·014	0·125

of the tests are plotted in Fig. 2. The cast size of the bars was 0·65in. in diameter.

All the bars were cast in green sand moulds from metal melted in a coke-fired crucible furnace. The crucible charges were made up from mixtures of Swedish white iron (3·8 per cent. total carbon), Armco iron, ferro-silicon (10 per cent. silicon), and ferro-manganese (80 per cent. manganese), to yield the desired composition. After the charge had melted down, the metal was superheated for approximately fifteen minutes, and then skimmed and poured.

It will be seen from the curves in Fig. 2 that silicon exerts a stiffening influence on cast iron at the temperature of the tests. The iron containing 6·62 per cent. of silicon is of the Silal type, and contains graphite in a finely divided state. The graphite flakes in the 13·77 per cent. silicon iron are also small, but those in the other two high-silicon irons are relatively coarse. This fact will be examined later

† A. L. Norbury and E. Morgan, *Journal* of the Iron and Steel Institute, 1931, No. 1, page 413.

in the section on graphite size. Fig. 3 shows deflections plotted against silicon contents at a load of 0·5 ton per square inch, *i.e.*, total deflection at the end of the fifth day of the test in each case. This shows clearly the increase in the rigidity of the irons as the silicon content is increased.

Air was able to enter the furnace during the tests, and this led to some scaling and growth, especially in the case of the low-silicon irons. Wastage of the specimens through scaling may be a contributory cause of the lack of rigidity of the two low-silicon irons. It will be noted from Fig. 2 that the deflection of the iron containing 3·28 per cent. of silicon was only slightly greater in the early stages of the test than that of the specimen which contained 6·62 per cent. of silicon. The sudden falling-off in the rigidity

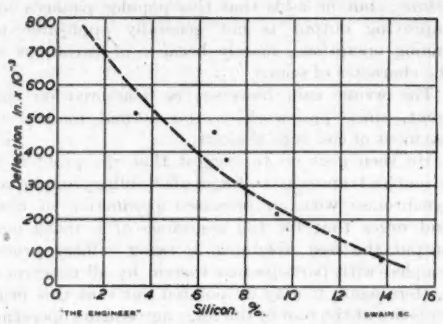

Fig. 3—*Deflection of Series A Bars After Five Days with Total Stress of 0·5 ton per square inch at 850 deg. Cent.*

in the case of the lower-silicon bar as the test proceeded, and as the load increased, may be explained partly by this deterioration of the metal under heat. The scaling of the Silal bar was only superficial, as was also that of the other high-silicon irons. An interesting point is that these high-silicon irons, which, as already mentioned, are extremely brittle in the cold, were found to bend under prolonged stress at 850 deg. Cent. The bar containing 13·77 per cent. of silicon gave a permanent deflection of 0·86in. at the free end of the test piece under a stress of 1·7 tons per square inch after twelve days at this temperature. (The stress was increased at the rate of 0·2 ton per square inch every twenty-four hours after 0·7 ton per square inch had been reached.)

The results of these tests show that additions of silicon of the order of 7 per cent. and more considerably increase the resistance of cast iron to deformation under load at high temperatures.

The Influence of Phosphorus on the Rigidity of Cast Iron at 850 deg. Cent.

In examining the influence of phosphorus, a base cast iron containing 5·5 per cent. of silicon was used, as this material scaled only slightly and had a very small growth. In this series, B, of bars tested, the phosphorus content varied between 0·4 and 1·1 per cent. The as-cast size of the bars in this case was 0·875in. in diameter.

The bars were produced from a mixture of mild steel scrap, refined pig iron and ferro-silicon (10 per cent. silicon), melted in a coke-fired crucible furnace. Additions of ferro-phosphorus (20 per cent. phos-

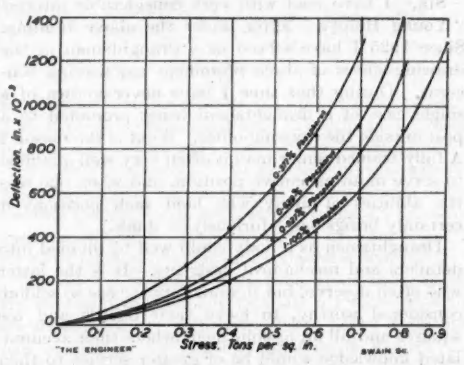

Fig. 4—*Deflection of Series B Bars at 850 deg. Cent.*

phorus) were made to the molten metal in the crucible before each bar was cast, the metal being returned to the furnace after each addition to bring it back to a suitable temperature for casting. The bars were cast in green sand moulds, and the pouring temperature was kept as uniform as possible throughout the series.

The analyses of the bars used are given in Table II.

Table II.—*Compositions of Irons, Series B (Increasing Phosphorus Contents)*

No.	T.C., per cent.	Si, per cent.	Mn., per cent.	S, per cent.	P, per cent.
7	2·40	5·59	1·20	0·035	0·377
8	2·47	5·50	1·17	0·043	0·639
9	2·42	5·42	1·14	0·039	0·927
10	2·41	5·42	1·13	0·040	1·100

Fig. 4 shows the deflections of these irons under

stress at 850 deg. Cent. It will be seen that additions of phosphorus progressively increase the stiffness of the metal at high temperatures. This stiffening influence is clearly shown in Fig. 5, where deflections are plotted against phosphorus contents for a stress of 0·7 ton per square inch, *i.e.*, total deflection of the specimen at the end of the seventh day of the test in each case. With the exception of the phosphorus content, the analyses of the bars are very similar, and it will also be seen that the microstructures are very much alike. All the bars scaled only superficially, so that it would appear that the differences in rigidity are entirely due to the differences in phosphorus content. It should be noted, however, that the graphite size of the specimen containing

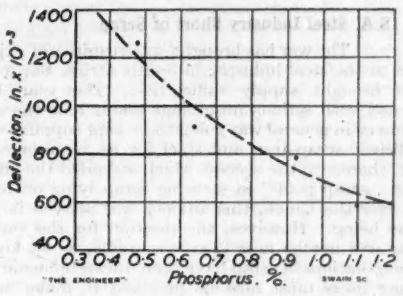

FIG. 5—*Deflection of Series B Bars After Seven Days with Total Stress of 0·7 ton per square inch at 850 deg. Cent.*

1·100 per cent. of phosphorus, the most rigid under test, is slightly coarser than that of the other bars in this series.

In order to examine the influence of phosphorus on cast iron of lower silicon content than Series B, two ordinary grey iron bars (Nos. 11A and 12A), containing approximately 3·2 per cent. silicon, but with widely differing phosphorus content, were tested (Series C). The as-cast size of the bars was 0·65in. in diameter. They were produced under similar conditions to the bars in Series A, and an addition of ferro-phosphorus (20 per cent. phosphorus) was made in the case of bar 12A.

The analyses are shown in Table III, and the results obtained are plotted in Fig. 6 (two lower curves).

It will be seen that the higher phosphorus bar is more rigid than the one with low phosphorus, although the difference in rigidity in this case is less marked than would be expected from the results obtained in Series B. Both bars in Series C, however, scaled on the surface and suffered from growth, and it is likely that this to some extent masked the influence of the differences in phosphorus content. The tests on bars of Series B and C do, however, show that additions of phosphorus increase the resistance of cast iron to deflection at 850 deg. Cent. over the range of silicon contents of the metal, 3·18–5·5 per cent.

THE INFLUENCE OF GRAPHITE SIZE ON THE RIGIDITY OF CAST IRON AT 850 DEG. CENT.

In order to examine the influence of graphite size, bars were cast in two different sizes from four different compositions. In each case the bar cast to the larger original diameter contained graphite in larger flakes than the small cast diameter bar.

The metal was melted in a coke-fired crucible furnace and cast into green sand moulds. Each pair of bars, of large and small diameter, was cast from the same crucible of molten metal. The components

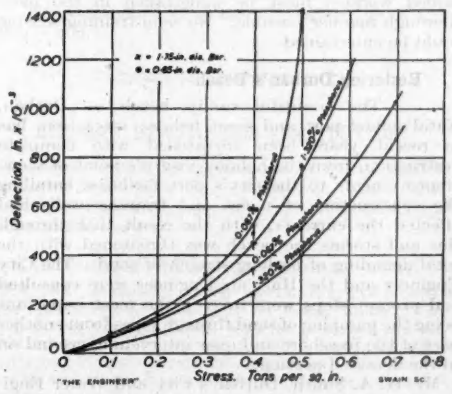

FIG. 6—*Deflection of Bars of Differing Phosphorus Contents, Series D, at 850 deg. Cent. (The Two Lower Curves also Constitute Series C, High and Low Phosphorus Contents.)*

of the charges were the same as those employed in Series A, with an addition of ferro-phosphorus in the case of the charge from which bars 12A and 12B were cast. The pouring temperature and moulding conditions were very similar for each pair of bars, and as far as possible were kept uniform throughout the series. The differences in structure in the two different sizes of bars of the same composition are due to the influence of the section on the rate of cooling.

The analyses of the bars, constituting Series D, are given in Table III :—

TABLE III.—*Compositions of Irons, Series D (Small and Large-diameter Bars)*

No.	Cast diameter. Inches.	T.C. Per cent.	Si. Per cent.	Mn. Per cent.	S. Per cent.	P. Per cent.
11A*	0·65	3·33	3·28	0·75	0·019	0·067
11B	1·75					
12A*	0·65	3·18	3·18	0·84	0·040	1·320
12B	1·75					
13A	0·65	2·53	5·75	1·06	0·048	0·036
13B	1·20					
14A	0·65	2·67	7·16	1·17	0·031	0·031
14B	1·20					

* Bars 11A and 12A constitute also Series C, high and low phosphorus contents.

Specimens for testing at 850 deg. Cent. were turned from these bars. The results obtained on bars 11A and 11B and 12A and 12B are plotted in Fig. 6. These bars have similar carbon and silicon contents, but contain different amounts of phosphorus. It will be seen that the smaller-cast bars resist deflection at 850 deg. Cent. better than the larger bars of the same composition in each case. The large cast diameter high-phosphorus bar is more rigid than the large diameter, low-phosphorus bar, showing that the phosphorus has a stiffening influence, even in large-diameter bars.

Fig. 7 shows the effect of the original casting section on the stiffness of bars 13A and 13B and 14A and 14B. Both these bars have high silicon contents and good heat-resisting properties. Here, again, the smaller bar in each case is better able to resist deflection than the larger bar of the same composition. While the higher silicon bars are stiffer than the lower silicon content bars of the same as-cast size, the lower silicon 0·65in. diameter as-cast bar is stiffer than the higher silicon 1·2in. diameter bar.

These tests show that for the same composition a cast iron with coarse graphite has less resistance to deflection at high temperatures than an iron containing fine graphite. Both silicon and phosphorus increase the stiffness of coarse graphite cast irons at the temperature of the tests.

An examination of the structures of the bars in the preceding series, however, in relation to their rigidity and composition, shows that small differences in graphite size are unimportant, and have less influence on resistance to deformation at the temperature of the test than relatively small changes in composition. An examination of the results obtained from the bars of Series D, however, shows that large

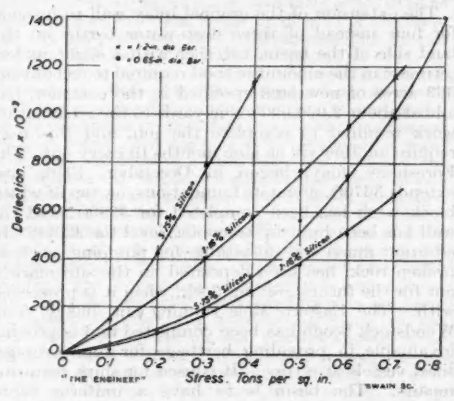

FIG. 7—*Deflection of Bars of Differing Silicon Contents, Series D, at 850 deg. Cent.*

differences in graphite size have a greater influence on rigidity than comparatively large differences in composition.

THE RIGIDITY OF CARBON STEELS AT 850 DEG. CENT.

Three plain carbon steels, forming Series E, were tested in order to obtain a comparison between their resistance to deflection at 850 deg. Cent. and that of cast iron. They had typical low, medium, and high carbon contents, the analyses being given in Table IV.

TABLE IV.—*Compositions of Steel Bars, Series E (Increasing Carbon Contents)*

No.	C, per cent.	Si, per cent.	Mn, per cent.	S, per cent.	P, per cent.
15	0·02	0·002	0·40	0·062	0·061
16	0·46	0·062	0·64	0·034	0·008
17	0·84	0·164	0·31	0·035	0·025

The test bars were machined from normalised steel rod, 0·75in. in diameter.

The deflections of these bars are shown in Fig. 8. It will be noted that the 0·02 per cent. carbon steel gave a deflection curve somewhat different from those obtained on the cast irons. Deflection is at first fairly rapid, and then slows up, finally becoming rapid again. A possible explanation for this was found when a section from the parallel part of the bar after test was examined under the microscope. This showed that crystal growth had taken place to a very considerable extent. It appears probable that as the crystals become larger, the resistance of the bar to deflection at high temperatures was increased. This conclusion is supported by the results obtained on the 0·84 per cent. carbon steel. Little grain growth occurred and the deflection curve of this bar is smooth. The bar scaled rapidly and the rapid deflection at the end of the test was no doubt

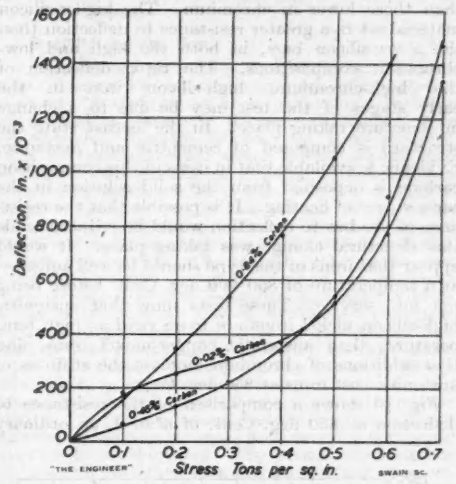

FIG. 8—*Deflection of Steel Bars, Series E, at 850 deg. Cent.*

due to wastage of the specimen. Grain growth took place to a considerable extent in the 0·02 per cent. carbon steel bar and to a smaller extent in the 0·46 per cent. carbon steel bar. There was little change in the structure of the 0·84 per cent. carbon steel after the test.

When these results are compared with those for the cast irons, it is found that the high-carbon (0·8 per cent.) steel deflected considerably more than any of the cast irons tested, with the exception of those with very coarse graphite structures (large-diameter bars). The medium-carbon (0·4 per cent.) steel had a resistance to deflection comparable with that of a cast iron containing 5·75 per cent. of silicon (0·65in. diameter bar).

THE RIGIDITY OF AUSTENITIC HEAT-RESISTING CAST IRONS AT 850 DEG. CENT.

The most important of the recently developed heat-resisting cast irons are the highly alloyed austenitic irons known as "Ni-Resist" and "Nicrosilal." The former contains nickel, copper, and chromium, and the latter nickel, silicon, and chromium. Both types of iron are made in a range of compositions to suit various conditions of service. Increasing the chromium content usually results in an increased resist-

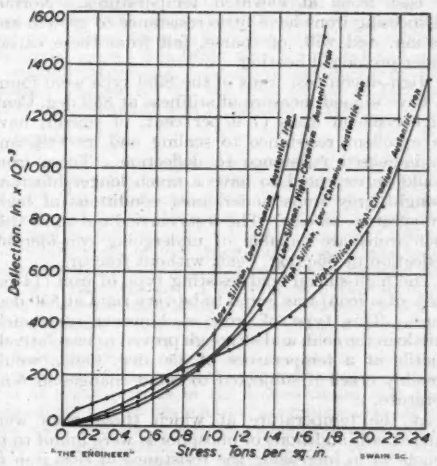

FIG. 9—*Deflection of Series F Bars at 850 deg. Cent.*

ance to scaling and growth, but high chromium renders the metal hard and practically unmachinable in the as-cast state. Two irons of each type, with high and low chromium contents, were tested, the compositions for this series (F) being as given in Table V :—

TABLE V.—*Compositions of Alloy Heat-resisting Irons, Series F*

No.	T.C., per cent.	Si, per cent.	Mn, per cent.	S, per cent.	P, per cent.	Ni, per cent.	Cr, per cent.	Cu, per cent.
18	2·51	1·63	0·53	0·073	0·270	16·40	2·51	7·35
19	1·79	5·90	0·76	0·027	0·033	17·15	1·95	—
20	2·23	2·00	0·54	0·029	0·190	15·74	11·95	7·10
21	2·18	4·91	0·49	0·039	0·031	18·65	7·25	—

All the bars were cast in green sand moulds from metal melted in a coke-fired crucible furnace. The metal was produced from charges consisting of Swedish white iron (3·8 per cent. total carbon), ferro-silicon (40 per cent. silicon), Armco iron and

ferro-chromium (70 per cent. chromium, 1·5 per cent. carbon), with small additions of ferro-phosphorus and ferro-manganese. Nickel was added as nickel F shot, and copper scrap was used for additions of this element. In each case the metal was melted down and superheated for 15 min. before pouring. The as-cast size of the bars was 0·75in. in diameter.

The resistance of these irons to deflection under load at high temperatures is shown in Fig. 9. The higher-chromium bars of each type are more rigid than those lower in chromium. The higher-silicon material offers a greater resistance to deflection than the lower-silicon bars, in both the high and low-chromium compositions. The rapid deflection of the high-chromium, high-silicon iron in the early stages of the test may be due to a change in structure taking place. In the as-cast state the structure is composed of cementite and austenite. Evidence is available that in irons of this composition carbide is deposited from the solid solution in the early stages of heating. It is possible that the resistance of the bar to deflection would be reduced while this structural change was taking place. It would appear that irons of this type should be well annealed at a temperature of 850–900 deg. Cent. before being put into service. These tests show that austenitic high-silicon nickel irons are more rigid at high temperatures than austenitic copper-nickel irons, and that additions of chromium increase the stiffness of austenitic cast irons at 850 deg. Cent.

Fig. 10 shows a comparison of the resistance to deflection at 850 deg. Cent. of a steel, an ordinary

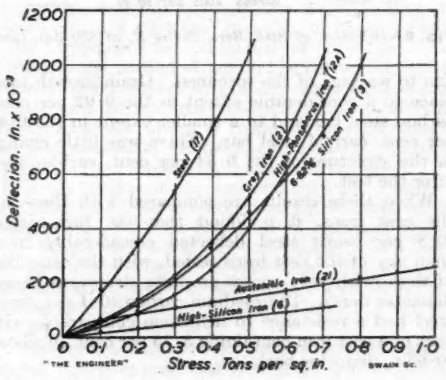

FIG. 10—*Deflection of Cast Irons and Steel at 850 deg. Cent*

good-quality grey cast iron, a high-phosphorus grey iron, a good heat-resisting iron of the Silal type, a high-silicon iron and a highly heat-resistant austenitic iron.

CONCLUSIONS

Many factors influence the resistance to deflection of cast irons at elevated temperatures. Normal engineering irons have little resistance to growth and scaling, and will, of course, fail from these causes under prolonged heating.

High-silicon cast irons of the Silal type were found to have a good measure of stiffness at 850 deg. Cent. Higher-silicon irons (7·9 per cent. of silicon) have an excellent resistance to scaling and growth, and an increased resistance to deflection. These irons would be expected to have a much longer life than straight grey irons under most conditions of high-temperature service. The tests carried out show that such irons are capable of undergoing considerable deflection at 850 deg. Cent. without fracture.

The high-silicon acid-resisting type of iron (14 per cent. of silicon) was found to be very rigid at 850 deg. Cent. This type of iron is, however, extremely brittle in the cold, and although proved to be relatively ductile at a temperature of 850 deg. Cent., would possibly crack if subjected to rapid changes in temperature.

At the temperature at which these tests were carried out, additions of phosphorus were found to be beneficial in increasing the resistance of cast iron to deflection. This was particularly so in the case of the higher-silicon irons. It should, however, be noted that the phosphide eutectic melts at a temperature of approximately 960 deg. Cent., and at temperatures of this order the presence of relatively small quantities of phosphorus is sufficient to cause almost complete loss of mechanical strength.

The austenitic irons "Nicrosilal" and "Ni-Resist" were found to have a good resistance to deflection at 850 deg. Cent. As these irons also have a marked resistance to scaling and growth, they are suitable for use under many conditions of service.

Graphite size has an important influence on resistance to deflection at high temperatures. It would appear necessary that grey cast iron for high-temperature service should have as fine a graphite structure as possible. This may be obtained by relatively rapid cooling of the metal from the molten state, or by the use of a low total-carbon content. The thickness of the casting should be kept to a minimum, as thick sections cool slowly, and this normally yields a coarse graphite structure. Slight differences in graphite size are, however, of less importance than relatively small changes in composition, *e.g.*, in silicon or phosphorus content.

Three plain carbon steels were tested, and it was found that these had less resistance to deflection at 850 deg. Cent. than many of the cast irons examined.

In using the data obtained from these tests in deciding on the most suitable type of iron for service at high temperatures, the conditions of service must be taken into account. If, for example, the service conditions entail heating the casting slowly to a uniform temperature, it is thought that an iron which is highly resistant to deflection will give better service than one which is less resistant. On the other hand, if the service conditions are such that the casting is subjected to steep temperature gradients, then it is possible that some stiffness must be sacrificed, and a less rigid iron will be better able to withstand these conditions. It is known, for example, that the high-silicon cast irons, shown to be very resistant to deflection at high temperatures, are susceptible to cracking under conditions where temperature gradients exist, while hematite irons with a coarse graphite structure give good service under conditions where considerable and rapid changes in temperature occur.

South African Engineering Notes

(By our South African Correspondent)

CAPE TOWN, July 26th.

Table Bay New Basin Nears Completion

IN the last week of June, with only eight days left to complete the 3½-year contract for building Table Bay's new £4,000,000 basin, the last but one of the eight deep-water berths with which it is to be provided was used for the first time, but work will continue for at least another six months. The delay in completing the contract has been due to an enlargement of the original scheme, and also to difficulties in obtaining materials as a result of the war. In view of these circumstances the contractors have obtained an extension of the contract time. The contractors are practically up to time on the original undertaking. Originally it was estimated that about 11,000,000 cubic yards (13,750,000 tons) of land would have to be reclaimed and 920,000 cubic yards (1,800,000 tons) of rock would have to be removed from the floor of the basin. So far 10,600,000 cubic yards (13,250,000 tons) of land have been reclaimed and 650,000 cubic yards (about 1,250,000 tons) of rock removed. Between 85 and 90 per cent. of the dredging within the basin has been completed, and an even higher percentage of the dredging in the approach channel.

The extension of the original quay wall to provide for four instead of three deep-water berths on the land side of the basin, together with a slight underestimate in the amount of spoil required to reclaim the 363 acres of new land specified in the contract, has added about 2,000,000 cubic yards to the reclamation work required to complete the job, and this may require another six or nine months to carry out. The Foreshore Quay, begun in December, 1936, now extends 3670ft. along its foundations, on top of which block work has been completed for 3380ft. and the wall has been built up to coping level for 3236ft. In addition much soil unsuitable for pumping, such as broken rock, has been deposited on the site marked out for the future graving dock, when it is proceeded with. The Eastern Mole running out 7000ft. from Woodstock beach has been completed and is proving invaluable in providing berthage for four average-sized vessels at a time. It is used for ships requiring repairs. The basin is to have a uniform depth throughout of 40ft., which will enable it to be used by the largest liners, even the "Queen Elizabeth."

The portion of the Foreshore Quay which was brought into use for the first time at the end of June is G berth. This berth was the last of the three provided under the 1937 contract, but later H berth was also authorised, and nearly half of its quay wall has already been completed. Twenty thousand-ton liners may now pass safely over the site of the old random block mole that used to enclose the original new basin. More than 30,000 concrete blocks, weighing up to 7 tons each, were removed in the demolition of the mole. When H berth is commissioned and the Foreshore Quay extends to the full 4000ft. at present authorised, there will be no fewer than twenty-three berths for deep-water ships in Table Bay harbour, twelve of them in the New Basin, a total more than twice as great as that available ten years ago.

Within the next few weeks a start is to be made with the laying out of the marshalling yard behind E and F berths to replace the present marshalling yard between Dock Road and the South Arm, which is too small. For the present only every second line is to be laid down in the new yard and the area between will be used for stacking purposes. When the new goods yard, to cost £1,000,000, is laid out on the reclaimed land at Woodstock after the war, this marshalling yard will be linked up with it.

Junction Ports Scheme

A "junction ports" scheme to make better use of Union harbours and to "speed the ships" of Britain and her allies, has been put forward by the Harbours and Shipping Committee of the Cape Town Chamber of Commerce, and other public bodies of the city. One portion of the scheme calls for an arrangement whereby slow ships carrying cargo from places in the South Atlantic or from the East, &c., to Britain, would tranship their cargoes into fast ships on arrival at Cape Town or other Union ports, for the rest of the voyage. It is urged their superior speed would enable them to sail unconvoyed, and so ships would make more voyages and carry more cargoes. A memorandum containing this and other far-reaching proposals to transfer Table Bay harbour from a peace to a wartime (twenty-four-hour day) footing has been drawn up. A deputation is to interview the Minister of Railways and Harbours and place the suggestions before him at an early date.

S.A. Steel Industry Short of Scrap

The war has brought opportunities of expansion to the steel industry in South Africa, but it has also brought supply difficulties. The year 1940 opened with serious misgivings about how the steel industry in general was going to be kept supplied with sufficient scrap iron and steel for its requirements; but, thanks to the success which attended the efforts of a "scrap pool" in securing scrap lying on farms all over the Union, this anxiety was allayed for the time being. However, the position for the current year will not be nearly so favourable, as all known accumulations of scrap have been drawn upon and the larger users must now be prepared to make heavy withdrawals from their stocks and use more pig iron. As far as the Union Steel Corporation (of South Africa) is concerned this will decrease the output from furnaces and increase the cost of production. The only source which can possibly be tapped for scrap are accumulations at the Union ports as the result of repairs and renewals to ships and also from the break up of wrecks on the Union coast. As to the latter source an experiment in breaking up wrecks situated at favourable points on the coast was tried some few years ago and proved to be too costly. Now, however, with prices much higher, it may be possible to obtain considerable quantities of scrap from this source on an economic basis.

S.A. Products Criticised

Mr. R. H. Harriss, in his presidential address to members of the South African Institution of Engineers, on July 12th, criticised some South African products. He said that owing to war conditions a large number of products—apart from engineering—were made in this country to-day which formerly were imported, and he regretted to say that many of these products were below the standard of the imported article, though the selling price was not. He thought if something could be done on the lines of the National Physical Laboratory at Teddington, as well as special inspection and testing to see that products were made to a definite South African standard specification, in every respect equal to the quality of imported goods, both the producer and the consumer would be sure of getting a satisfactory article. Such products bearing the stamp "South African made" would then impart the same confidence as that now enjoyed by goods bearing the world-wide slogan "British made." They were trying to expand industrial production and war production has shown clearly that under proper supervision there was every opportunity for expansion, but they must have an adequate supply of suitable steels of proven quality at an economic cost, also they needed efficient and well-trained technical men of long experience to organise and carry out such work and the training of skilled men, mechanics, artisans and even semi-skilled workers must be undertaken in the most thorough manner possible. No semi-training scheme could be entertained.

Restoring Durban's Beach

The beautiful sandy beach at Durban, Natal's chief port and great holiday attraction, has in recent years been threatened with complete destruction, from the holiday visitor's point of view. Improvements to the city's port facilities, entailing the construction of moles and training walls had affected the currents, with the result that through this and storms the beach was threatened with the total denuding of its long stretch of sand. The City Engineer and the Harbour Engineer were consulted and prompt steps were taken; the most important being the pumping of sand through pipes from another part of the foreshore and over intervening ground on to the denuded portion.

Mr. H. A. Smith, Durban's City and Water Engineer, recently read a paper to the Institution of Municipal and County Engineers in which he revealed that Durban's beach has grown by 73 acres since sand pumping started in 1939. In that time £480 has been spent on repairing damage, but in the five years ended July 31st, 1938, more than £26,000 was spent on beach protection works and repairing storm damage. "There can be on doubt," said Mr. Smith, "that had there been no sand cushion along the North Beach, particularly during the year when very severe storms were experienced, the damage and cost of repairs would have been far in excess of that incurred in any previous period. Sand pumping is a progressive step towards beach restoration, in spite of occasional losses of sand during during storms.

Erosion and foreshore damage are not only retrogressive, but entail losses which become greater and more destructive as the years go by. Between 1903 and 1937, when a survey of the beach was made, 37½ acres of land had been lost from the South Beach. In 1938 a survey was made; twelve months after the Administration began to pump sand, depositing it near Vetch's Pier, and six months after the Corporation had been pumping sand northwards from Vetch's Pier, and it was found that 24½ acres had been reclaimed in that time. In three years more than 73 acres of Durban's lost beach have been restored."

Coking in South Africa

The Union of South Africa is exceptionally fortunate, generally, in its mineral wealth, but as regards good coking coal it is not quite so well served, and although the known coal reserves are estimated to be in the region of 250,000 million tons, the greater proportion appears to be non-coking. A further complication in a country of such vast proportions is the location of coking coals in relation to the most economic point of consumption. The manufacture of coke in South Africa in by-product recovery ovens began after the Great War with the erection of a battery of ovens at Waschbank, Natal. The initiative was taken by the directors of the Dundee Coal Company, Ltd., and the plant which was designed and erected by Coppee Company (G.B.), Ltd., started to produce coke in October, 1922. Initially thirty stamp-charged horizontal waste heat coke ovens were built, carbonising a charge of approximately 10 tons of coal, containing 10 per cent. moisture, in thirty-nine hours. Provision was also made for future extensions, and in 1926 a start was made on the enlargement of the battery to its present size of fifty ovens. Coke was pushed from the first of these twenty new ovens in May, 1927.

In April, 1939, rebuilding from just above the waste heat flue level was begun on the original thirty ovens. The procedure was to lay the ovens off in sections, six at a time. They were then stripped, built up and brought into operation again. By April, 1940, the full battery was once again in commission. It is interesting to note that the original thirty ovens produced for close on seventeen years, more or less continuously, during which time more than 700,000 tons of coke were turned out. The total production of coke from all the ovens at Waschbank during this period is well over one million tons. At the present time the battery of fifty ovens is producing 6300 to 6400 tons per month, and in addition there is a small battery of beehive ovens with an output of approximately 1000 tons per month. On the by-product side, after a small experimental plant had produced a benzol of satisfactory quality, a larger plant was installed towards the end of 1928. This was designed and all the units made in South Africa, and at present the plant is producing about 3000 gallons of motor spirit and 1000 gallons of solvent naphtha per month.

Up to 1928 all the ammonia was converted to sulphate of ammonia by the direct process. During that year experimental plant was installed with a view to producing concentrated ammoniacal liquor, and numerous tests regarding concentrations were carried out at Waschbank. When it became evident that a concentrated liquor to the specification required could be manufactured, a plant was erected, and from 1929 the rate of production has been at the rate of 240 tons per annum of actual ammonia. The production of sulphate of ammonia was discontinued immediately the new plant was brought into operation. On account of the growing demand for tar products, additions were also made to the tar distillation plant in 1926, and at the moment the crude tar is being distilled to produce road tar, tar prime, pitch and various oils.

BRITISH STANDARDS INSTITUTION

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HARD-DRAWN PHOSPHOR BRONZE WIRE

B.S. 384. A revision of this specification has recently been undertaken in order that its scope, which before covered only plain or tinned wire for armature binding, could be modified to provide for hard-drawn phosphor bronze wire for general engineering purposes. The present revision accordingly does not now cover the special mechanical properties required primarily for armature binding. Certain important modifications have been introduced into this revision, the principal of which are as follows:—(a) Tinned wire and low tin grade are excluded; (b) margins of manufacture have been given as definite figures instead of as a percentage; (c) the tensile strength figures have been modified, and the bend test requirements have been adjusted.

TIN STATISTICS.—It is estimated that world production of tin in the month of July amounted to 18,100 long tons, compared with 19,900 tons in July of last year. Production for the first seven months of this year was 147,900 tons, against 125,100 tons in the same period of 1941.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Sweden's Raw Materials Rationed

In a recent broadcast the Swedish Minister of National Economy gave an account of the raw material situation in Sweden. He referred to the serious effects the present import difficulties had had on Sweden's industry. The shortage of coal and coke had been especially felt. The restrictions in the supply of fuels to industry had been made especially stringent since spring of this year. In May the total coal consumption by industry was reduced to one-third of the normal monthly consumption in 1939, and it had been further cut down during the summer. The cement industry had been hit particularly hard by the shortage of coal. The output of steel, computed in ingots, was slightly smaller during the first half of this year than in the corresponding period of 1940, and had not quite attained the quantity estimated by the Industrial Commission as being required for covering this year's requirements. The supply of commercial steel, such as plate, was liable to shrink from possible shortage of pig iron and scrap, while the situation in respect of quality steel was more favourable on account of the present elimination of several of the most important export markets for Swedish steel. This unfavourable development had lightened the situation for domestic consumers. The supply of copper was limited, and it had been necessary to regulate the consumption according to a general plan. Agreements had been concluded for increasing the domestic production of copper by about one-third. Strict economy was also necessary with regard to aluminium, although it had been possible to keep the stocks fairly constant through imports from Norway and Switzerland and through domestic production. A new aluminium factory using Swedish andalusit as raw material would be started next year in co-operation with the State. The domestic production, however, was dependent on certain agents and raw materials were difficult to obtain. The stocks of tin on hand were relatively large, but the prospects of obtaining fresh supplies from abroad were practically nil. For this reason, and in view of the demands for tinplate by the canning industry, it would be necessary to husband the resources. The stock of lead was scanty and the situation on this score unsatisfactory. Increased lead mining was projected with Government assistance. The prospects of importing zinc were brighter as the production of this metal may also be started in Sweden.

The Pig Iron Market

Although the general demand for pig iron is steady, it is not so large as that which ruled a few months ago. The position generally has not materially altered and there is still a noticeable stringency in the hematite department and, to a lesser degree, in supplies of low-phosphoric foundry iron. On the North-East Coast the volume of business in foundry pig iron consists principally of small parcels for early delivery and there seems to be no likelihood of an extension in the production of Cleveland iron. By now, however, the local foundries have become accustomed to the use of Midland brands and these are available in sufficient quantities to meet consumers' requirements. Most of the producing plant on the North-East Coast is engaged upon basic iron for the steel works, and the production of this class of pig iron is maintained at a high level. The position in the Midlands is satisfactory and the demand is on a fairly heavy scale. The heavy engineering foundries are particularly large buyers and home-produced high-phosphoric irons are being used to a greater extent than was formerly the case. The distribution of hematite supplies is carefully supervised by the Control and only where the use of this iron is essential are supplies liberated to users. The demand for high-phosphoric iron, however, is not so heavy as to throw any strain upon the producing plants, and reserves are being accumulated to meet any possible emergency in the winter. In Scotland the pig iron position appears to be satisfactory and although considerable quantities are passing to the marine and heavy engineering foundries the demand does not fall far short of the supply. There has been no improvement in the position of the light casting makers, but the bigger demand from other industries has to a great extent offset this decline.

The Midlands and South Wales

For some weeks the demand for structural steel, particularly for joists and sections of the heavier sizes, has been on the decline, but during the past week there has been an improvement in the flow of specifications, which has given rise to the belief that requirements are again rising. All the steel works are fully employed and have enough orders on their books to keep them busy for months, so that the recent falling-off in business did not have an important effect upon this branch of the industry. Constructional engineers are not so well employed as they were a year or even six months ago, and although it is prophesied that the lull is only temporary, it has yet to be seen whether the recent revival is of a permanent character. The plate position is sound and very large tonnages continue to be called for by the shipyards, tank builders and wagon builders. The sheet works are not over burdened with work and business in this department has been quiet for several weeks. There is a certain amount of irregularity in this department, since some works still have enough orders on their books to keep them busy, while others could do with considerably more work. The curtailment of imports of semi-finished steel does not appear to have had any influence upon deliveries. Home production is on a good scale and consumers have had sufficient warning to enable them in many cases to build up some reserves. The re-rolling industry is fully employed and the demand for the lighter sections has not fluctuated to the same extent as the heavier sizes. There has been a constant call for small steel bars and the production of these has been well maintained. The South Wales iron and steel works are still actively employed largely upon Government account. There has been a reduction in the output of steel, as the requirements of consumers in some branches have declined. The tinplate industry is working well below capacity as a result of the restrictions on export, and the only moderate demand from home sources.

Scotland and the North

Although there have been some minor declines in the demand for manufactured steel, it is sufficient to absorb the whole of the home production. Probably the demand is heaviest in the plate department, since the shipyards continue to take up large tonnages, whilst the tank makers and wagon builders are also large consumers. The engineering industry continues to use important quantities of steel bars, and this demand is likely to continue; whilst the call for ferro-concrete bars is particularly strong. The production of armour plate is maintained at a high rate and seems to be sufficient to meet requirements. The general feeling in the steel consuming industries is that the position has materially improved during the past few months and that the future can be looked forward to with confidence. Structural steel is not in such heavy request as a few months ago and although there are slight fluctuations the tendency seems to be for business to fall off to a small extent. Lately there has been an upward movement in the demand, although whether this foreshadows a return to the intense activity of a year ago seems doubtful. Constructional engineers are less busy but continue to provide a fairly good outlet for joists and sections. The demand seems particularly good for the lighter sizes and the re-rolling works are kept extremely busy. In the Lancashire market active conditions rule in the steel trade and the works have a big accumulation of orders on their books. The request for bars is maintained, but quicker deliveries of the smaller sizes are obtainable from some works. With regard to the larger diameters, the position is still somewhat stringent. Great activity rules in the special steel section and wire drawers are all busy. There is a quiet demand for sheets and some of the works would be glad to obtain fresh business. On the North-West Coast the works are maintaining their production of finished steel, which is passing into immediate consumption. Prices are unaltered and there seems to be no expectation of any change for some time.

Lead and Spelter

The British lead position has shown no important change for some time. There is, of course, a steady demand from the war industries, which is being adequately met by the Control, and any small delays in deliveries are generally due to transport uncertainties. The situation in the United States is also satisfactory, and the recent purchase by the Metals Reserve Company of 225,000 tons of lead from Canada and Mexico for delivery over the second half of this year has improved the outlook. It is reported that the United States will purchase a further important quantity from Peru when shipping facilities can be arranged. Imports of lead ore in the United States from January to May inclusive this year total 23,360 tons, compared with 31,430 tons in 1940, whilst the exports for the same period total 85,250 tons, compared with 34,500 tons in 1940.... The consumption of spelter by the British war industry is at a high rate, but the situation is by no means tight. The Control, whilst watching the situation closely, is able to keep the war industries fully employed. There seems to be little available for ordinary commercial needs. The world situation of spelter seems to remain rather tight. American statistics give the exports of spelter for the first five months of 1941 as 26,500 tons, compared with 20,100 tons in 1940.

Copper and Tin

In spite of the heavy consumption of copper for war purposes, the position in Great Britain remains satisfactory. The supplies reaching this country from the Dominions producing this metal are sufficient to keep the war industries fully supplied. A certain amount of manufacture for export is also proceeding. Copper has been released for the production of copper sheets required by India, a certain amount of business with this country having been transacted lately. In the United States the position remains stringent, but the Control in operation over there is apparently able to find sufficient metal for the rearmament programme, and is able to keep the plants engaged upon civilian work well supplied. It is urged in some quarters in the United States that the requirements for the rearmament programme has taken copper away from trades supplying manufactured products to the domestic market, but this, of course, is unavoidable in the circumstances. Although there has been some talk of the position getting tight later on, it seems unlikely that with the South American production available the United States is likely to go short of this metal. The question is probably one of transport, and difficulties may occasionally arise in finding the necessary shipping space.... Interest is felt in the forthcoming meeting of the International Tin Committee which, it is understood, will take place towards the end of September, although no date has yet been fixed. The question of quotas and the prolongation of the international agreement for a further period will probably be discussed. At present the quotas stand at 130 per cent. of the standard, and it is possible that this may be adhered to. In the present war situation, however, the future is by no means certain. For instance, Thailand, a tin producer, is threatened by the Japanese, and the situation in some other countries may also be precarious, and an invasion of some of them would alter the whole world position of the metal. There has been little feature in the London market, or, for the matter of that, in the United States, and no one appears to anticipate any violent price movement. There has been some discussion in the United States regarding the stabilisation of prices for domestic sales. If that were to happen the question would arise whether it would be necessary to control the tin market in London, which at present is the only free non-ferrous metal market.

Notes and Memoranda

Rail and Road

SHIPYARD WORKERS' TRANSPORT.—Conferences have taken place between Merseyside shipbuilding employers, trade union representatives, and transport authorities to consider the need for the provision of improved transport for shipyard workers. It is hoped that if certain proposals are put into practice there will be less congestion during peak hours of travelling and a saving of time of workers delayed in travelling.

BLIZZARD DAMAGE ON THE L.N.E.R.—The magnitude of the damage and dislocation caused to L.N.E.R. telegraph and telephone services by the blizzard that raged in North-Eastern England last February is revealed by the fact that the work of repair has only just been completed. No less than 10,000 insulators and 4000 miles of copper wire were required for the work of repair, which has been carried out continuously since February by the L.N.E.R. engineer's department, assisted by the military authorities.

THE JAIPUR STATE RAILWAY.—During the financial year ended August 31st, 1940, the Jaipur State Railway increased its route mileage open for traffic from 215 to 245 miles. The gauge is metre, and the rolling stock on the above date consisted of sixteen steam locomotives, four petrol railcars, forty-six coaching, and 335 goods vehicles. Gross earnings during the year under review amounted to Rs. 17,26,076, and working expenses to Rs. 9,60,440, leaving as net earnings the sum of Rs. 7,65,636. The line is owned and worked by the native State of Jaipur.

SWEDISH TRAIN FERRY.—The Swedish State Railways have recently asked for tenders for a new train ferry vessel for the Malmö-Copenhagen service. It is expected that the vessel will replace the present "Malmö," which is forty years old and no longer answers the requirements, as it cannot take the latest heavy all-steel passenger vehicles. Particulars published in the *Railway Gazette* state that the new ferry will be 309ft. long and carry two tracks with a total length of 480ft. Diesel propelling machinery developing 4500 H.P. is to be provided, and the speed will be 15 knots. In addition to the railway vehicles the vessel will have room for 1300 passengers, or 1800 if not carrying trains; all modern conveniences, such as air conditioning, will be provided. If required, the vessel will be able to run on the Sassnitz-Trälleborg route, being equally suited to the berthing facilities on both routes.

CANADIAN RAILWAY EARNINGS.—Figures recently published show that the gross earnings of the Canadian National Railways during July were 25,655,442 dollars, an increase of 3,260,410 dollars, and operating expenses were 20,739,130 dollars, an advance of 2,516,684 dollars, leaving net earnings 4,916,312 dollars. Aggregate gross earnings for the seven months from January 1st were 167,370,930 dollars, an increase of 31,294,347 dollars, and the net earnings of 37,024,523 dollars show an increase of 16,651,855 dollars. The gross earnings for July of the Canadian Pacific Railway were 19,359,000 dollars, an increase of 4,056,000 dollars, and expenses were 16,164,000 dollars, or 3,265,000 dollars higher. Net earnings at 3,195,000 dollars were 791,000 dollars more than for July, 1940. For the first seven months of 1941 gross earnings were 119,199,000 dollars, an increase of 28,511,000 dollars, and the net earnings of 23,115,000 dollars were 8,074,000 dollars greater than for the first seven months of 1940.

RAILWAY WAGON-BUILDING PROGRAMME.—It is reported from America that plans are being discussed by officials of several of the large railway systems for a 1000 million dollar freight wagon-building programme, which may involve some form of Government financing. Recently, states the *Railway Gazette*, leading railway executives have expressed the view that the heavy programme of wagon building which is in hand as a defence measure, and which will involve 330,000 wagons during the next two years, will place too heavy a strain on the financial structure of the railway, and that outside assistance may be needed. It is believed that the scheme under consideration may take one of two forms—a Federal Government wagon corporation, the funds for which would be furnished by the Reconstruction Finance Corporation and which would lease wagons to the railways; or a wagon corporation formed by the Association of American Railroads, the funds for which would be supplied by the Government or the carriers or both. It is pointed out that the 1000 million dollar investment would call for interest payments of about 20 million dollars for the first year, and also annual amortisation payments amounting to about 60 million dollars if a fifteen-year period were involved. The new programme would not include the purchase of locomotives, since the individual undertakings appear willing to finance whatever purchases of this kind are necessary.

Air and Water

THE LIFEBOAT SERVICE.—In the first two years of the war the boats of the Royal National Lifeboat Institution have been launched 2006 times to ships in distress and have rescued 4058 people.

THE EMPIRE AIR TRAINING SCHEME.—While on a visit to the first all-Canadian R.A.F. Fighter Station to be established in Great Britain, Mr. Mackenzie King, Prime Minister of Canada, said that the Empire air training scheme had surpassed the expectations of everyone by what had so far been accomplished.

AIR PATROL OF TRANSMISSION LINE.—The Montana Power Company has started to patrol its portion of the new Montana, Idaho, and Utah transmission line by aeroplane. The length of line under its jurisdiction, from Anaconda sub-station to the Montana and Idaho line, is approximately 126 miles, across a country consisting for the most part of rolling hills and deep canyons. To patrol the line in the ordinary way would require several men and a truck, but by aerial patrol one man does it in a hired plane with pilot. The machine is a two-passenger Cub training plane, flying at about 70 m.p.h. At this low speed and flying not to exceed 300ft. above the wires, it is possible to spot major defects in the line. When trouble is located the aeroplane goes to the nearest landing field and reports back, as two-way radio facilities have not yet been provided.

WESTINGHOUSE TURBINE PLANT.—The Westinghouse Electric and Manufacturing Company has announced the building of a plant for the manufacture of steam turbines and gears for use in merchant ships of the United States Maritime Commission. The new plant will be operated, it is understood, under a lease agreement with the Defence Plant Corporation, a subsidiary of the Reconstruction Finance Corporation, which is advancing funds for the plant. The plant will adjoin the Westinghouse South Philadelphia steam division works, and will employ more than 1500 workmen. Construction of the new ship-equipment shops has already been begun, and it is expected that the building, containing nearly 9 acres of manufacturing space, will be completed in eight months. Machine tools will be installed and production should start in about sixteen months. The steam turbines to be delivered annually at the plant will have a total capacity of 630,000 H.P., enough to drive 100 ships carrying 1,000,000 tons of cargo.

CONTROL OF WRECKS.—The Minister of War Transport has issued the Dock and Harbour Undertakings (Control of Wrecks and Other Obstructions) Order, 1941. Its provisions include:—(1) Every power conferred upon a dock or harbour undertaking over vessels sunk, stranded, or abandoned, or over any other wreck or obstruction or danger to navigation or over any property recovered therefrom, including every right to recover from any person all or any of the expenses incurred in dealing therewith, shall be exercised by that undertaking without publication of the exercise or intended exercise of that power and without the necessity for obtaining the consent of any other person; and the obligations or limitations imposed with respect to that undertaking by or by virtue of any Act or other instrument determining the functions of the undertakers shall be relaxed accordingly; (2) in this Order the expression "vessel" shall include every article or thing or collection of things being or forming part of the tackle equipments, cargo stores, or ballast of a vessel.

Miscellanea

MINERS' CANTEEN PLANS.—Plans to increase miners' food have been announced by the Mines Department. The Miners' Welfare Commission is to provide funds for colliery canteens, conditional on colliery owners clearing the site and being responsible for the establishment of the canteens, and the Food Ministry will send additional supplies of food—rationed and unrationed—for miners free of coupons for consumption at the colliery. Each canteen will be run on a non-profit basis by a committee of miners and owners.

SCRAP CONSUMPTION IN AMERICA.—American consumption of iron and steel scrap in the first five months of 1941 is estimated at 22,127,000 gross tons, compared with 14,730,000 tons in the corresponding period of 1940, according to statistics issued by the Institute of Scrap Iron and Steel. Beginning with last October, domestic consumption has exceeded 4,000,000 gross tons for six months, and has barely been under 4,000,000 tons in two months. The result has been to drain away available supplies without giving the industry an opportunity to accumulate material.

EXPLOSIVE RIVETS.—An explosive rivet, made of aluminium alloy, for use at points which are accessible only from one side, has been developed by E. I. Du Pont de Nemours and Co. The explosive is detonated by an electric heating gun, one man setting fifteen to twenty rivets per minute. A small charge of explosive in the shank of each rivet expands it accurately to a predetermined tightness when the electric heat is applied momentarily to the head. In addition to use in aircraft, it is believed that these rivets may find application in other industries. Manufacture in larger sizes, and of other metals, including steel, seems to be possible.

RAILINGS FOR SCRAP.—The Ministry of Works has stated that iron gates and railings from undamaged private houses are expected to produce 500,000 tons of scrap iron. Instructions have been issued to Local Authorities throughout Great Britain to compile a list of all unnecessary gates and railings, except those serving a safety purpose or having historic interest or artistic merit, and when these lists are completed the scrap will be removed. If a gate or railing is easy to remove, private owners should do it themselves to save time and labour. A recent Order in Council absolves tenants from obligation to landlords for railings in their charge. Receipts will be given for all that is removed, and compensation will be paid in due course. A survey of railings on or around the 18,000 buildings in charge of the Ministry of Works is now in progress to supplement the hundreds of tons of scrap taken from the Royal parks and Government buildings.

ROOFING SLATES.—Since February, 1941, the slate-quarrying industry has been operating under the direction of the Ministry of Works and the Slate Quarries Executive Committee. Instructions have been issued by the Director of Roofing, Ministry of Works, indicating the methods to be followed when supplies of roofing slates are required, and in accordance with these instructions slates are only supplied for Government priority work and for urgent air raid damage repairs. Orders should be placed through local merchants, who must obtain a permit from the local Assistant Director of Emergency Works or the Emergency Works Officer of the Ministry of Works, or from the Reconstruction Panel of the Ministry of Aircraft Production. A permit should be sent with each order to one of the following committees:—Cornish Slate Quarries Regional Committee, Delabole, Cornwall; Welsh Slate Quarries Regional Committee, Port Penrhyn, Bangor, North Wales; Westmorland Slate Quarries Regional Committee, Martins Bank Chambers, Keswick-on-Derwentwater. The Regional Committee will arrange for delivery to be made from the quarry best able to supply or may transfer orders to another committee if necessary. The demand for roofing slate has eliminated all stocks of large sizes, and the officers issuing permits have been instructed to arrange for the use of small sizes wherever possible, as these can be delivered from stock in each region. Merchants and contractors are asked to co-operate in the use of small sizes of slates, as it is only by this means that the slate-quarrying industry can meet the heavy demands due to air raid damage.

Personal and Business

MR. W. W. WOOD has been elected Master Cutler of Sheffield for the second year in succession.

MR. D. S. A. E. JESSOP has been appointed chief labour officer of the Brush Electrical Engineering Company, Ltd.

THE PALNUT COMPANY, Ltd., informs us that its London office has been transferred to Joymance Works, Cambridge Grove, Hove, Sussex.

MR. J. W. PARKER, of the Detroit Edison Company, has been nominated President of the American Society of Mechanical Engineers.

MR. T. J. TIERNEY, chairman and managing director of Richard Hughes and Co. (Liverpool), Ltd., has been elected to the Mersey Docks and Harbour Board.

WE regret to note the death, on September 3rd, of Mr. Walter Leahy Mansergh, M. Inst. C.E., of James Mansergh and Sons, Consulting Engineers, Westminster.

MR. F. C. STUBBOCK has been appointed a Director for the Port of Durban, for the co-ordination of the authorities of departments concerned with harbour working.

MR. MAURICE WILSON, president of the Royal Bank of Canada, has been appointed Chairman of the British Supply Council in North America, in succession to the late Mr. Arthur Purvis.

THE Gas Administration Section, Board of Trade, has moved from Chapter Street House, Chapter Street, S.W.1, to New Oxford House, Bloomsbury Way, W.C.1. Telephone, Holborn 4311. The Gas Testing Section will remain at Chapter Street House.

WE regret to announce the death, at the age of seventy-seven, of Mr. George Patterson, who spent the whole of a sea career in the service of the Cunard Company. Mr. Patterson was appointed chief engineer of the "Aquitania" after service in the "Ascania," "Alaunia," and "Lusitania," and left the latter liner on the voyage before she was torpedoed by an enemy submarine. During the last war Mr. Patterson held a commission as Engineer-Commander in the R.N.R., and was awarded the O.B.E. in 1919. He retired in 1926.

THE Minister of Supply has made the following appointments:—Mr. J. C. Patteson, Controller-General of Transportation, has been appointed Director-General, Supply Services. While continuing to be responsible for transport and storage, Mr. Patteson will, in addition, co-ordinate the flow of special manufactured stores. He will also control all Ministry of Supply motor vehicles, and the distribution of petrol, and will supervise the Department of the Controller of Building Construction. Mr. A. Forbes Smith, Assistant Controller-General of Transportation, has been appointed Deputy Director-General, Supply Services, and will control the Transportation Department. Major F. Gilbert, Controller of Factory Transportation, has been appointed Assistant Director-General, Supply Services. His successor as Controller of Factory Transportation is Mr. L. G. Burleigh. Mr. T. Muir Wilson has been released by the Board of Trade, where he held the appointment of Deputy Controller of Factory and Storage Premises, and has been appointed Director of Storage and Distribution. Wing Commander R. H. Berryman, on loan from the Air Ministry, has been appointed Controller of Vehicles and Petrol under D.G.S.S.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Electrical Engineers

Thursday, September 18th.—INSTALLATIONS SECTION. Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, H. T. Young; and "Space Heating by means of Electrically Warmed Floors as Applied to Surface-type Air Raid Shelters," R. Grierson. 6 p.m.

Saturday, September 20th.—N. MIDLAND STUDENTS' SECTION. Visit to X-ray department of Leeds Infirmary. 2.30 p.m.

Institution of Mechanical Engineers

To-day, September 12th.—S. WALES BRANCH: S. Wales Inst. of Engineers, Park Place, Cardiff. "The Engineering Aspects of A.F.S. and A.R.P.," P. J. Plevin. 5.30 p.m.

Thursday, September 18th.—MIDLAND BRANCH. James Watt Institute, Great Charles Street, Birmingham. "The Naval African Expedition to Lake Tanganyika," C. E. Cobb. 6 p.m.

Friday, September 19th.—Grosvenor House, Park Lane, W.1. Luncheon. 12.45 for 1.15 p.m.

Saturday, September 27th.—YORKS BRANCH. The University, Leeds. "Combustion, Detonation, and Turbulence in Petrol Engines," W. T. David. 3 p.m.

Society of Engineers

Wednesday, September 17th.—Visit to E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. 2.30 p.m.

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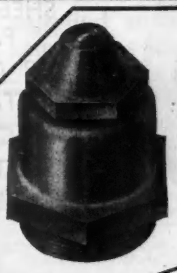
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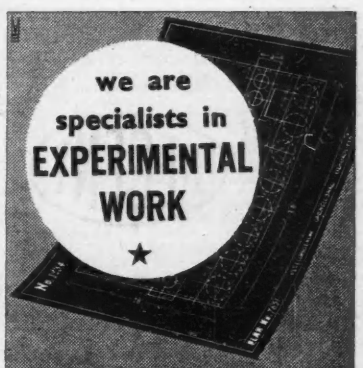

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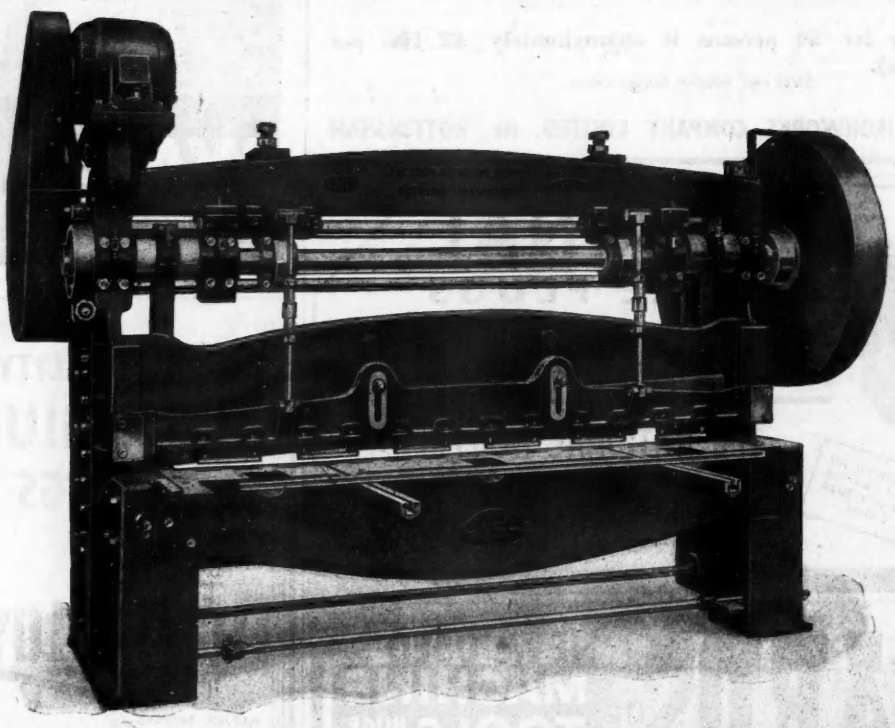

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